A star (*) indicates that the Abstract deals with Apparatus and Instruments.

MARCH, 1939.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

882. Helium Atom. D. Buchanan. *Roy. Soc. Canada, Trans. Sect.* III. 32. *pp.* 53–64, *May*, 1938.—The problem considered is the determination of orbits for the three bodies which approach asymptotically the libration points of the normal atom. No attempt is made to use any of the methods of modern atomic physics, Newtonian mechanics alone being employed. A. H.

883. Reaction between Very Light Nuclei. T. Nagakura. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 977–996, *Dec.*, 1938. *In English.*—A mathematical method developed for treating the reaction between light nuclei is formally analogous to Wheeler's resonating group structure method [see Abstract 393 (1938)], but the problem is approached from a physically and mathematically different viewpoint and a simplified treatment is obtained. N. M. B.

884. Molecular Structure of Hydrogen Fluoride. S. H. Bauer, J. Y. Beach and J. H. Simons. *Am. Chem. Soc., J.* 61. *pp.* 19–24, *Jan.*, 1939.—An electron diffraction study of gaseous HF resulted in patterns which are incompatible with a hexagonal structure wherein the F atoms are at the corners and the H atoms at any position along the sides; agreement between observed and calculated intensity curves was found, however, when a zig-zag chain configuration was assumed. The fuzziness of the rings strongly supports the view that a number of different polymers are present. Best values for the interatomic distances are: F–H $1{\cdot}00 \pm 0{\cdot}06$ Å; F– – –H $1{\cdot}55 \pm {\cdot}06$ Å; F–H– – –F $2{\cdot}55 \pm {\cdot}03$ Å. The average FFF angle is $140 \pm 5°$, and the H atoms are in line with the F atoms ($\pm 15°$). The possibility that the saturated vapour consists of the monomer and a chain or ring hexamer which dissociates into various chain-like fragments before the photographs are taken, when the vapour suddenly is allowed to expand into the evacuated chamber, has not been eliminated definitely; but this appears unlikely for there are a sufficient number of collisions in the gas nozzle for the gas to reach its equilibrium composition. Several of the properties of liquid HF have been correlated on the basis of a continued equilibrium between chain polymers, and the difficulties of this assumption are also indicated. AUTHORS.

885. Inorganic Giant Molecules. H. G. Grimm. *Naturwiss.* 27. *pp.* 1–11, *Jan.* 6, 1939.—The four types of chemical linking (ionic, metallic, van der Waals, and homopolar) are discussed, and the results of the determination of the structure of characteristic molecules containing these linkings by the method of projection of the electron density on to certain planes are reviewed. Examples of inorganic giant molecules, especially silicates, are considered, and the connection between the type of linking and the practical use of solid substances is dealt with. [See following Abstract.] A. J. M.

886. Natural Organic Giant Molecules. K. Freudenberg. *Naturwiss.* 27. *pp.* 17–22, *Jan.* 13, 1939.—The principle of continuous

condensation by which giant organic molecules (*e.g.*, polypeptides, carbohydrates) are built up is discussed. The structural form of these molecules is also considered. **Errata,** *ibid. p.* 80, *Feb.* 3, 1939. [See preceding Abstract.] A. J. M.

887. Electronic Structure of Polyenes and Aromatic Molecules. Part VII. C. A. Coulson. *Roy. Soc., Proc.* 169*A*. *pp.* 413–428, *Feb.* 7, 1939.—A new definition of the order of a given bond in an aromatic compound is proposed, based upon the method of molecular orbitals. This order depends upon the coefficients of the wave functions in the occupied molecular orbitals; it is also related to the forces acting along the given link. A curve is drawn relating the order of a bond and its length, and the method is applied to a discussion of the orders and lengths in the conjugated chain molecules $C_{2n}H_{2n+2}$. [See Abstract 905 (1938).] AUTHOR.

888. Structure of Liquid Secondary Amines. B. V. Thosar. *Zeits. f. Physik*, 110. 7–8. *pp.* 436–442, 1938.—The molecules of $(n\ C_3H_7)_2NH$, $(iso\ C_3H_7)_2NH$, $(n\ C_4H_9)_2NH$, $(n\ C_5H_{11})_2NH$, $(iso\ C_5H_{11})_2NH$, $n\ C_5H_{11}NH_2$ and $(n\ C_5H_{11})_3N$ have been examined using Cu Kα radiation, and are found to have a pyramidal structure similar to that of NH_3. The Bragg distance d has the constant value of 4·46 Å for all the n-secondary amines, and this is the usual distance between carbon chains lying parallel to one another. In the liquid state the molecules must lie each in the pyramidal space formed by the carbon chains of its nearest neighbour. F. J. L.

889. Molecular Association. E. Lucatu. *Comptes Rendus*, 207. *pp.* 1403–1405, *Dec.* 27, 1938.—The relation between the viscosity η and the vapour pressure p has been investigated and found to obey the law $p\eta^a = 10^k$, where a is a coefficient and k a constant depending on the liquid. Acetone, ethyl ether, methyl acetate, methyl alcohol and ethyl alcohol were studied, both above and below the ordinary boiling points. When the logarithms of p and η are plotted straight lines are obtained, two for each substance, having one slope in one region and another slope in another region. These regions correspond to different states of molecular association. Two exceptions to this general rule were found—Hg for which a hyperbola was obtained and water for which two intersecting hyperbolæ were obtained, their point of intersection being 40° C. which is also the temperature of minimum compressibility. These hyperbolæ apparently represent states of varying molecular association. G. G.

890. Molecular Weights and Association of Solutes in Liquid SO_2. G. Jander and H. Mesech. *Zeits. f. phys. Chem.* 183. *Abt.A.* 4. *pp.* 277–296, 1939.—For a number of inorganic and organic substances, electrolytes and non-electrolytes, the facts that the degree of dissociation and the molecular weight are independent of the constitution of the molecule and the nature of the ions forming the salt, are established. In general non-electrolytes are dissolved as single molecules, and the little dissociated pseudo acid thionyl compounds also yield simple molecular weights. On the other hand, binary salts—according to the criterion of van 't Hoff's factor i—are more or less associated in concentrated solution, especially KCNS. In very dilute solution the i values for binary salts approach 2, in accordance with theory. Various possible theories regarding the molecular structure of the dissolved solutes and the mechanism of solvation are discussed in special reference to previous work. [See also Abstract 1345 (1939).] D. R. H.

891. Spectroscopic Determination of Atomic Number of Polonium. H. Hulubei, Y. Cauchois and S. Cotelle. *Comptes Rendus*, 207. *pp.* 1204–1206, *Dec.* 12, 1938.—The X-ray emission spectrum of Po deposited electro-chemically on the antikathode was measured and the lines $L\alpha_1$, $L\alpha_2$, $L\beta_1$, $L\beta_2$ and $L\gamma$ were identified. The wave-lengths agreed excellently with those predicted by Moseley's law for an element of atomic number 84. W. S. S.

See also Abstracts 926, 972, 973, 1006, 1088, 1099, 1184, 1215, 1216, 1278, 1374.

COLLOIDS.

892. General Theory of Thixotropy and Viscosity. C. F. Goodeve. *Faraday Soc., Trans.* 35. *pp.* 342–358, *Feb.*, 1939.—Thixotropy is generally assumed to arise from the presence of " structure " in colloidal solutions. The various types of structure proposed are here criticised and arguments are put forward to show that only one type, a scaffolding structure, is capable of explaining all the experimental observations. It is shown that non-Newtonian viscosity may be considered to consist of two independent parts, one Newtonian, the other thixotropic. The latter may be attributed to the interference between the particles and the formation of links. These links when stretched and broken give rise to a series of impulses (a transfer of momentum) from a moving layer to a neighbouring layer. The amount of each impulse is shown to be *inversely* proportional to the rate of shear and the number of impulses per second *proportional* to the rate of shear. The product, the total force due to these links, is therefore independent of the rate of shear, a behaviour found with thixotropic substances. The theory also suggests an explanation of the difference between Newtonian and thixotropic viscosities. It appears to be of general application to colloidal systems in which there is interference between the particles, and can be used to explain the thixotropy of emulsions and foams. AUTHOR.

893. Dialysis in Study of Colloids. Part V. Colloidal Au. Part VI. Colloidal V_2O_5. B. N. Desai, P. M. Barve and Y. S. Paranjpe. *Roy. Soc. Edinburgh, Proc.* 59. 1. *pp.* 22–37, 1938–1939.—Measurements of kataphoretic speed in the presence and absence of electrolytes, stability towards electrolytes, and conductivity of colloidal solutions of Au and V_2O_5 (and viscosity in the case of V_2O_5) which have been dialysed, diluted, allowed to age, and exposed to sunlight to different extents are made, and data on the variation of the first named set of quantities with the progress of dialysis, dilution, and ageing are given. On adding small increasing amounts of electrolytes having univalent coagulating ions the kataphoretic speed first increases and then decreases; with electrolytes having bivalent coagulating ions it continuously decreases in the case of Au, and first decreases, then increases, and again decreases in the case of V_2O_5. The conception of a critical potential is not supported. An interpretation of results is discussed. [For Part IV see Abstract 440 (1937).] N. M. B.

894. Nature of Solutions of Na in Liquid NH_3. S. Freed and H. G. Thode. *J. Chem. Phys.* 7. *pp.* 85–86, *Jan.*, 1939.—The previous conclusion of Krüger [see Abstract 4284 (1938)] that solutions of Na in liquid NH_3 are colloidal and that therefore the interpretations of the author's magnetic measurements require revision is regarded as untenable. The phenomena observed by Krüger are considered to be due to insufficient precautions in preparing the solutions. Evidence from magnetic measurements is

adduced in support of the view that the metal is present in non-colloidal solution. L. A. W.

895. Viscosity and Particle-Size. E. A. Hauser and D. S. le Beau. *Kolloid Zeits.* 86. *pp.* 105–107, *Jan.*, 1939.—The viscosity of dilute Bentonite sols containing particles of known size, in the range 10–200 $m\mu$, was found to decrease with increasing particle size and finally to reach a constant value. This is an example of the little-investigated descending branch of the maximum-curve, postulated by Wo. Ostwald, of the general function between viscosity and particle-size. The steepness of the curve in the region of the finer particles, as well as the relatively high value of the viscosity for the larger ones, was attributed to the high degree of hydration of the disperse particles. W. H. Wal.

896. Electrokinetic Potential. Parts III and IV. K. Kanamaru and T. Takada. *Kolloid Zeits.* 86. *pp.* 77–93, *Jan.*, 1939.—These papers continue a previous investigation [see Abstract 3052 (1938)]. In Part III an analogy is now schematically drawn between the ionic double layer- and the dipole double layer-types with respect to structure. The conclusion is then derived that the value (μ/V) of the ζ-potential of a definite solid phase with respect to a homologous series of appropriate organic liquids has a relationship expressed by the equation $\zeta = A(\mu/V)^B$, where A and B are constants. It is theoretically derived that the Coehn rule is invalid if one of two neighbouring phases is non-polar, but valid when both phases are polar. The relationship between the ζ-potential of a solid phase with respect to relevant homologous organic liquids and the dielectric properties D, D_g, is given by the empirical equation, $\zeta = k[(D-D_g)/D](\mu/V)^m$, where k and m are constants. Part IV deals with the electrokinetic potential of sulphur with respect to alcohols. Sulphur compared with glass has an appreciably smaller ζ-potential and a somewhat feebler reduction of potential with time. The ζ-potential of sulphur in alcohols with the exception of methyl alcohol decreases with the length of the hydrocarbon chain of the alcohol. These results are discussed from the standpoint of the theory of lyophility of the solid phase and from the theory of Part III. The papers are replete with data and diagrams. H. H. Ho.

897. X-Ray Diffraction Patterns of Crystalline Sol Rubber. G. L. Clark, S. T. Gross and W. H. Smith. *Bureau of Standards, J. of Research*, 22. *pp.* 105–107, *Jan.*, 1939.—Included in an earlier publication on the X-ray diffraction patterns of sol, gel, and total rubber, obtained from stretched and from frozen specimens, was a pattern of discrete gel rubber crystals which had been formed in an ethereal solution at temperatures between — 40° and — 50° C. Attempts to obtain a pattern of sol crystals, formed similarly in ethereal solution, failed, in spite of the fact that an examination of them in polarised light indicated a crystalline structure. By using more of the crystalline sol rubber, and a shorter distance from specimen to film in the X-ray technique, a pattern has been obtained, the measurements of which agree with those reported for the crystals mentioned in the previous paper [see Abstract 4788 (1937)]. Authors.

***898. Apparatus for Filtering, Washing and Extracting. G. Kapsenberg.** *Kolloid Zeits.* 86. *pp.* 18–30, *Jan.*, 1939.—This paper describes a system of apparatus by means of which filtration, washing, and extraction can be carried out automatically. The interchangeability of the component parts makes the apparatus suitable for a variety of purposes. [See following Abstract.] W. H. Wal.

***899. Percolators and Perforators. H. Dieterle.** *Kolloid Zeits.* 86. *pp.* 31–32, *Jan.*, 1939.—The author describes an apparatus (perforator) by means of which extraction can be carried out continuously, the extracting liquid being circulated (by vaporisation and condensation), via a sintered glass filter, through the mixture to be extracted. A description of Kapsenberg's percolator is given, and its advantages are discussed. [See preceding Abstract.] W. H. Wal.

***900. Speed-Measuring Devices for High-Speed Centrifuges. E. G. Pickels.** *Rev. Sci. Instruments*, 9. *pp.* 354–358, *Nov.*, 1938.—A direct reading stroboscope is described, in which the frequency is controlled by means of a synchronous motor, for measuring centrifuge speeds between 12,500 and 50,000 r.p.m. F. J. L.

***901. Air Bearing for Air-Driven High-Speed Centrifuges. E. G. Pickels.** *Rev. Sci. Instruments*, 9. *pp.* 358–364, *Nov.*, 1938.

***902. Electrically-Driven Magnetically-Supported Vacuum-Type Ultracentrifuge. J. W. Beams and S. A. Black.** *Rev. Sci. Instruments*, 10. *pp.* 59–63, *Feb.*, 1939.—A large rotor or centrifuge, an armature, and a small iron rod are anchored coaxially one above the other, in the order named, on a small flexible shaft. The shaft passes through a vacuum-tight oil gland which seals a vacuum-tight chamber surrounding the large rotor. A direct current which energises an electromagnet situated vertically above and coaxial with the iron rod is adjusted so that the pull on the iron rod is slightly greater than necessary to support all of the rotors. The extra lift is balanced by a slight thrust against the upper end of the shaft by an oiled bronze stop in the pole piece of the electromagnet. The adjustments are made to maintain a small air gap between the rotating iron rod and the stationary pole piece. The rotors are driven by a piezo-electrically-controlled a.c. through the field of a single-phase induction motor which surrounds the armature. Six-inch centrifuges have been spun to over 1000 r.p.s. at very constant speed. Authors.

903. Pulverisability of Substances. A. H. M. Andreasen, N. Hofman-Bang and N. H. Rasmussen. *Kolloid Zeits.* 86. *pp.* 70–77, *Jan.*, 1939.—The idea of pulverisability of various substances is comprehensively discussed and an apparatus proposed for the determination of this fundamental property. Experimental details are given for 40 substances chosen from a wide range of compounds. It is proposed to give to each separate substance a characteristic number indicating its pulverisability, and it is shown how this property is related to its degree of fineness. It is noteworthy that for an ordinary substance having the degree of fineness of flour, the pulverisability decreases with increase of fineness, and that a strong increase of pulverisability occurs when from such material the finest particles have been removed. The paper concludes with a discussion of the data from a physico-chemical standpoint, and contains several illustrative diagrams. H. H. Ho.

See also Abstracts 937, 995, 1142, 1183, 1319, 1320.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

904. Identity of Laue Equations and the Bragg Relation. A. Cavinato. *Zeits. f. Krist.* 100. 5. *pp.* 443–444, 1938. *In Italian.*—The identity between the Laue equations and the Bragg relation is demonstrated from simple elementary geometrical considerations. C. J. B. C.

905. Inequality Concerning Lattice Sums. B. S. M. Rao and K. V. Iyengar. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 524–528, *Nov.*, 1938.—

In the course of an investigation of the optical anisotropy of a liquid, using as a model a rhombic lattice of static dipoles, some inequalities connected with lattice sums were encountered. These are now described. C. B. A.

906. Lattice Defects in AgBr Crystals. F. Seitz. *Phys. Rev.* 54. *pp.* 1111–1112, *Dec.* 15, 1938.—Volume conductivity of ionic crystals can only exist if there are free vacancies or free interstitial ions in the lattice. This can occur if positive or negative ions leave the lattice sites and enter interstitial positions, or if they leave lattice sites and move to the surface. W. Jost and G. Nehlep [see Abstract 2353 (1936)] conclude that defects of the first type occur more commonly than those of the second in the silver halides. The writer is of the opinion that the use of certain equations in this work is unjustified. He derives another method of carrying out the calculation, but the result of these calculations is too small a figure to allow a differentiation between the two types of defects. G. G.

907. Theory of Building-Up of Crystals. W. Kossel. *Ann. d. Physik*, 33. 7. *pp.* 651–660, *Dec.*, 1938.—In view of the importance universally attached to the crystal lattice, the author is concerned whether the importance of plane formation may not be overlooked. He cites the old method of " light figures " obtained from spheres and discusses the various phenomena obtainable, from a theoretical standpoint. D. R. H.

908. Superlattice Formation of Type AB in an Adsorbed Layer. T. S. Chang. *Cambridge Phil. Soc., Proc.* 35. *pp.* 70–83, *Jan.*, 1939.—The possibility, pointed out in a previous paper [see Abstract 2237 (1938)], of superlattice formation in an adsorbed layer when the adsorbed atoms tend to repulse each other is developed in detail. Both Bragg and Williams's approximation and Bethe's approximation are used, but restricted to superlattices of the type AB. In a range of θ, the fraction of surface covered, a superlattice is found to be possible. Bragg and Williams's approximation shows further that the state with the lowest free energy is the one with a superlattice when the latter is possible. Rough kinetic expressions are also given. The equations derived from the principle necessary to preserve equilibrium are found to reduce to those of detailed balancing, and they also agree with the formula obtained statistically. As expected, all the corresponding results obtained from the two methods become the same when the number of nearest neighbours of a site approaches infinity, provided that the product of this number and the interaction potential of two adsorbed atoms occupying two neighbouring sites remains finite. The only significant result is the large value of the slope of isotherms (the rate of change of the pressure with respect to the fraction of adsorption) when there is a nearly complete superlattice AUTHOR.

909. Radiograph of a Crystal with Close-Packed Hexagonal Lattice. M. Masima, M. Kuroda, S. Sakui and H. Watanabe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 858. *pp.* 1705–1739, *Nov.*, 1938. *In English.*—The face-centred cubic, body-centred cubic and close-packed hexagonal lattices are found most commonly in metal crystals. The atlases of radiographs of crystals having the two former lattices have already been published. An atlas of radiographs of a crystal of the hexagonal class is now given. Metals of this class include Mg, Zn, Cd, Be, Ti, α-Co, Zr. The axial ratios vary for these crystals, and though the radiographs differ more or less according to these ratios, the

atlas has been made for a Mg crystal. With the aid of the 128 photographs it is possible to find the orientation from Laue photographs of a crystal.
C. J. B. C.

910. Electronic Structure of Cu-Al Alloys. J. Farineau. *Comptes Rendus*, 208. *pp.* 191–192, *Jan.* 16, 1939.—In continuation of previous work [see Abstract 3906 (1938)] the author reports that the spectrum of the 5·2% Cu alloy in which ageing has been studied by Guinier and Preston [see *Nature*, 142. *p.* 569, 1938] shows no appreciable variation when photographed at intervals of two months. The difference in energy between order and disorder does not therefore exceed the resolving power of the spectrograph, *i.e.*, 0·1 eV/atom; in agreement with Mott's calculated value of 0·04 eV. Intensities of the bands Lα due to Cu, and Kβ_x due to Al, in the intermetallic compound $CuAl_2$ (the basis of age-hardening alloys) are reported between limits of 923–936 and 1543–1556 eV respectively, with those of the pure metals for comparison. On the reasonable assumption that the electrons in the latter are free, one may deduce for conduction electrons 3 Brillouin zones with maxima at 6, 8, and 10·5 eV confirming experimental results. The Cu band gives evidence of the presence of satellites due to ionised atoms, and the maxima which are not coincident with those of the pure metal appear to correspond with those of the band Kβ_x.
D. R. H.

911. Structures of Nickelous Acetate Tetrahydrate and Cuprous Acetate Monohydrate. R. B. Hull. *Univ. of Pittsburgh, Bull.* 35. *pp.* 142–149, *Oct.* 1, 1938.—X-ray and goniometric methods give the following crystal data for the above compounds. (1) Ni $(CH_3COO)_2 \cdot 4H_2O$; monoclinic prismatic; $a = 8 \cdot 46 \pm 0 \cdot 005$, $b = 11 \cdot 75 \pm 0 \cdot 01$, $c = 4 \cdot 754 \pm 0 \cdot 005$ Å, $\beta = 93° 34'$; 2 mol. per unit cell; density = 1·714; space group $C_{2h}^5 - P2_1/a$. (2) $Cu(CH_3COO)_2 \cdot H_2O$; monoclinic prismatic; $a = 13 \cdot 176 \pm 0 \cdot 007$, $b = 8 \cdot 463 \pm 0 \cdot 015$; $c = 13 \cdot 89 \pm 0 \cdot 02$ A, $\beta = 117° \cdot 06'$; 8 mol. per unit cell; space group $C_{2h}^6 - C2/c$. The atomic positions in each compound are discussed in relation to the symmetry elements and the unit cell dimensions.
J. I.

912. Crystallography of Potassium Tetrathionate. G. Tunell, H. E. Merwin and C. J. Ksanda. *Am. J. Sci.* 35*A*. *pp.* 361–372, 1938.—Analysed artificial crystals of $K_2S_4O_6$ are investigated and their geometrical elements and optical constants determined; also, the dimensions of their structural unit cell and their space-group.
AUTHORS.

913. Unit Cell and Space-Group of β-Glycine. C. J. Ksanda and G. Tunell. *Am. J. Sci.* 35*A*. *pp.* 173–178, 1938.—The dimensions of the structural unit cell of β-glycine, all determined by purely X-ray measurements, are $a_0 = 5 \cdot 07$, $b_0 = 6 \cdot 23$, $c_0 = 5 \cdot 37$ Å, all $\pm 0 \cdot 01$ Å, $\beta = 113° 27' \pm 15'$. β-glycine crystallises either in the space-group $C_{2h}^2 - P2_1/m$ or in the space-group $C_2^2 - P2_1$.
AUTHORS.

914. Electron Density and Interatomic Distances in Tetragonal Pentaerythritol. I. Nitta and T. Watanabé. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 855. *pp.* 1669–1680, *Nov.*, 1938. *In English.*—An analysis of the structure of the above compound by the Fourier method is described and the results obtained agree more exactly with these of Llewellyn, Cox and Goodwin [see Abstract 3357 (1937)] than did those given in an earlier paper by the present authors. The bond distance C — CH_2 is found to be 1·53 Å which is almost identical with that of the aliphatic C atom. The authors discuss the question of H-bond formation and conclude that there is direct evidence of its existence in these

crystals. The angle between the bond of the methylenic C atom to the central C atom and that to the hydroxyl O atom is found to be very nearly tetrahedral. J. I.

915. Nature of Cyclol Bond. I. Langmuir and D. Wrinch. *Nature*, 143. *pp.* 49–52, *Jan.* 14, 1939.—The authors explain the mechanism of the formation of the cyclol bond and show that several properties of proteins may be interpreted on the basis of cage structures which are built on the hypothesis of the cyclol bond. It is stated that the breaking of cyclol bonds yields different degradation products according to the path of fragmentation and this will explain the characteristic films formed by different proteins. The question of resonance in protein structures is discussed and it is claimed that on the cyclol hypothesis structures can be built having a high degree of resonance. This may explain why apparently minor changes in protein molecule structure can cause important changes in their biological effects. It is shown that probably only small forces are required to open cyclol bonds, therefore any direct evidence on protein structure will depend on physical investigations which do not involve the breakdown of the intermolecular and intramolecular structure. J. I.

916. X-Ray Study of Carbonisation of (a) Cellulose and (b) Bituminous Coal. H. E. Blayden, H. L. Riley and A. Taylor. *Chem. Soc., J. pp.* 67–75, *Jan.*, 1939.—The dimensions of the graphite crystallites in cokes prepared under different conditions over the temperature range 400–1300° from (*a*) cellulose and (*b*) coal have been determined from Debye-Scherrer powder photographs. As the temperature increases, the crystallites show a relatively rapid growth along the *a* axis up to 700°, above which the growth is much slower. In each case the *c* dimension remains constant over the range of carbonising temperature studied. The *c* spacing is apparently dependent upon the number of layer planes in the individual crystallites, increasing as this number decreases. An attempt has been made to determine the relationship between the number of unsaturated border atoms of the hexagon planes in the crystallites and the disordered organic matter. The results indicate that when the carbonisation temperature reached 600–700°, the amount of disordered organic matter is insufficient fully to satisfy the valency requirements of the border carbon atoms. This fact explains the abrupt changes which occur in the properties of cokes prepared at this carbonisation temperature. AUTHORS.

917. Chemical and X-Ray Analysis of Dental, Mineral and Synthetic Apatites. J. Thewlis, G. E. Glock and M. M. Murray. *Faraday Soc., Trans.* 35. *pp.* 358–363, *Feb.*, 1939.—On the basis of chemical and X-ray analysis it is suggested that the apatite present in dental enamel consists mainly of hydroxy-apatite in which a small amount of Ca may be replaced by Mg. It is also suggested that the carbon present in dental enamel and in mineral and synthetic apatites is present as carbonate, and that the observed variations in lattice dimensions are connected with the presence of some element or elements not determined by the chemical analysis, except in so far as they are due to differences in the type of apatite present. AUTHORS.

918. Theory of Liquid Crystals. L. S. Ornstein. *K. Akad. Amsterdam, Proc.* 41. 10. *pp.* 1046–1048, 1938. *In English.*—A. van Wijk and the author have shown that the phenomena in the surface layer of liquid crystals may be described by an equation of the form: $A(d^2\phi/dx^2) - aH^2 sin\phi cos\phi = 0$, where x is a direction perpendicular to the surface, ϕ the

angle of the swarms with the x-axis, and H the strength of the magnetic field, while α and A are appropriate constants relating to the volume and interaction of the swarms respectively. Recently Zocher and Fürth [see Abstract 2245 (1938)] have discussed whether this equation can only be deduced from the theory of swarms, and the author in reply points out that difficulties arise because the above approximation equation is incomplete and that the full equation of motion for the swarm is $B(d^2\phi/dt^2) + \beta(d\phi/dt) - F = \int f(x - x^1)g(\phi - \phi^1)\,dx^1 - \alpha H^2 \sin\phi\cos\phi$, where B is the moment of inertia, β is the coefficient of internal friction and F a fortuitous force. The author distinguishes two extreme cases : (1) where the Brownian force is small compared to the interaction of the swarms given by the integral, which occurs in the surface layer where the strong forces exerted by the wall orient the first layers of the swarms; (2) where the Brownian couple is strong compared with the individual interaction couples, and the neighbourhood can thereby show fortuitous differences in orientation which are large or small. The work of the Russian school is discussed in this connection.

H. H. Ho.

919. Mobile Annuli Produced in Anisotropic Drops of the Nematic Phase by the Addition of an Optically Active Substance. P. Gaubert. *Comptes Rendus*, 208. *pp.* 43–45, *Jan.* 3, 1939.—The mobile annuli produced at the free surface of *p*-azoxyanisole containing phloridzine [see Abstract 514 (1939)] are also formed when other substances of very different composition are introduced, some being dextrorotatory and others laevorotatory. The possibility of a new method for the determination of the rotatory power and sense of rotations of an active substance is indicated.

H. H. Ho.

920. Liquid Crystalline Solutions of Sodium Palmitate and Sodium Laurate in Water. R. D. Vold and M. J. Vold. *Am. Chem. Soc., J.* 61. *pp.* 37–44, *Jan.*, 1939. The vapour pressure of aqueous sodium laurate at 90° has been measured as a function of its concentration and the existence of waxy soap as a separate phase has been confirmed. The activities of sodium palmitate and sodium laurate have been calculated for each of the phases present in aqueous systems at 90°. Possible models of each of these phases are described. The models proposed account qualitatively for the experimental activity concentration curves of middle soap and neat soap.

AUTHORS.

***921. Vacuum Furnace for Production of Single Crystals. F. C. Nix.** *Rev. Sci. Instruments*, 9. *pp.* 426–427, *Dec.*, 1938.—In order-disorder experiments on single crystals of metals and alloys it is important to prevent oxide inclusions and gas occlusions, because of their possible influence on the results. A furnace is described for the production of single metallic crystals by the usual (Bridgeman) method, carrying out the cooling process *in vacuo*. Diagrams and constructional details of the furnace are given. It is stated to have been used to produce, with great care, single crystals of Cu and of Cu-Au alloys, 8 mils in diameter and 7 inches long with variations of chemical composition along the length less than 0·5%. The vacuum used, when the metals are in the molten state, was about 10^{-3} to 10^{-4} mm. Hg.

G. G.

922. Production of Crystals Suitable for Physical Measurements. R. Jouan. *Comptes Rendus*, 208. *pp.* 206–207, *Jan.* 16, 1939.—The method of obtaining single crystals, *e.g.*, of alum, by suspending a nucleus by a hair in a slightly oversaturated solution is unsatisfactory, by reason of the hair. A better method is described in which the nucleus

rests on artificial silk netting supported on a glass plate, which oscillates slowly (once in 4 seconds) in such a solution. Accurate octahedra of alum are thus obtained. C. A. S.

923. Study of β-Brass in Single Crystal Form. W. Webb. *Phys. Rev.* 55. *pp.* 297–305, *Feb.* 1, 1939.—The resistances of 20 single crystals of brass in the β-phase have been measured as a function of temperature from room-temperature to about 550° C. for the purpose of studying the order-disorder phenomenon. The results obtained are compared with the theory of Bragg and Williams. The resistivities at 25° C. as a function of composition place the limits of the β-phase at 51·3 and 55·5 atomic % Cu. A study of the thermal e.m.f. of the crystals against Cu shows only a slight discontinuity in the second derivative of the e.m.f.-temperature curve at the temperature of complete disorder. The e.m.f. curves themselves are quite smooth. Young's modulus, E, for ten of the crystals, measured at room-temperature, gives the elastic constant S_{11}, ($44{\cdot}8 \times 10^{-13}$ cm^2./dyne) and the combination of constants, $2S_{12} + S_{14}$, ($0{\cdot}028 \times 10^{-13}$ cm^2./dyne). A graph of 1/E against the orientation function ($l^2m^2 + m^2n^2 + n^2l^2$) is linear. From it the ratio of the maximum to minimum E is found to be 8·94. Below the elastic limit the stress-strain relation is linear with no permanent set nor hysteresis. AUTHOR.

924. Optical Properties of Transparent Crystals. P. Burgatti. *N. Cimento*, 15. *pp.* 439–461, *July*, 1938.—The paper is in the nature of a review of the electromagnetic theory of the optical properties of transparent crystals. C. J. B. C.

925. Optical Orientation in Elongate Clastic Quartz. R. G. Wayland. *Am. J. Sci.* 37. *pp.* 99–109, *Feb.*, 1939.—It is argued that if clastic quartz grains are more resistant to abrasion in certain crystallographic directions, their shapes will be an expression of this differential hardness. To test the idea, a thin section of St. Peter sandstone was found which showed noticeably elongate, parallel grains. A petro-fabric diagram of this section shows that the direction of elongation coincides with the direction of the optic axis of the quartz. An independent check consists of actual measurements of grains of Jordan sandstone, showing that they are 17·6% longer in the direction of the optic axis than normal thereto. The possible significance of these findings is discussed briefly. AUTHOR.

See also Abstracts 935, 1197, 1200, 1201, 1236, 1237, 1239, 1258, 1259, 1273, 1278, 1292, 1352, 1374, 1384, 1395, 1396.

DENSITY.

926. Volume Changes in Methyl Alcohol-Toluene System. L. S. Mason and H. Paxton. *Am. Chem. Soc., J.* 61. *pp.* 67–69, *Jan.*, 1939.—The relative densities of solutions of methyl alcohol and toluene have been measured over the entire concentration range at − 21·1, 0·0, 25·0 and 49·7°. The volume changes attending mutual solution of the two liquids are calculated from these densities and the volume changes at a temperature near the boiling point are estimated by extrapolation. Suggestions are offered as to the nature of the association, dissociation and solvation effects which may be responsible for the observed behaviour. AUTHORS.

927. Specific Gravities and Refractive Indices of Aliphatic Sulphides. G. W. Ayers, Jr., and M. S. Agruss. *Am. Chem. Soc., J.* 61. *pp.* 83–85, *Jan.*, 1939.—Specific gravities at 0°/4°, 20°/4° and 25°/4° are determined for pure samples of ethyl, *n*-propyl, isopropyl, *n*-butyl,

isobutyl, *n*-amyl and isoamyl sulphides. Refractive indices at 20 and 25° for the D sodium line are also determined for the same sulphides. From these values the molecular refraction values are calculated.

AUTHORS.

928. Densities of D_2O–H_2O Mixtures. E. Swift, Jr. *Am. Chem. Soc., J.* 61. *pp.* 198–200, *Jan.*, 1939.—The densities of a series of mixtures of H_2O and D_2O have been measured at 5 and 25°. From the standpoint of density, these mixtures form ideal solutions at both temperatures. The equation derived for ideal solutions is recommended for calculating the composition of a mixture from the density. AUTHOR.

See also Abstracts 1011, 1018, 1019, 1272.

DIFFUSION AND OSMOSIS.

929. Diffusion of Hydrogen through Nickel. C. B. Post and W. R. Ham. *J. Chem. Phys.* 6. *pp.* 598–605, *Oct.*, 1938.—The diffusion of H_2 through commercial and very pure anodic Ni has been studied between 1100° and 150° C. The diffusion rates vary in a perfectly regular manner throughout this range, except for a discontinuity at the Curie point (360° C.), and exact agreement with the formula $R = AT^z p^y e^{-b/T}$ was found in all cases. After long heat treatment with H_2 the value of y is $+ 0{\cdot}50 \pm 0{\cdot}01$ except possibly near the Curie point. The maximum slope of the isotherms is in the Curie region and $> 0{\cdot}5$, but approaches $0{\cdot}5$ as the heat treatment progresses. The magnetic transition is abrupt, and there is a sudden drop in the value of b at the Curie point as calculated from the equation $R = Ae^{-b/T}$. There are no systematic breaks in the isobars at high temperatures, but the value of z indicates that the H_2 possesses considerable energy within the lattice. A possible process for the change from ferromagnetic to paramagnetic condition in the transition elements is the movement of an electron from the 3*d* shell to one of the 4 levels, followed by the drop of another 4-level back to such a 3*d* level as to result in the pairing of electron spins in the 3*d* shell. F. J. L.

930. Permeability of Neoprene to Gases. T. P. Sager and M. Sucher. *Bureau of Standards, J. of Research*, 22. *pp.* 71–79, *Jan.*, 1939.—The specific permeability of neoprene to H_2, He and CO_2 at 25° C. is shown to be about one-fifth to one-sixth that of rubber. Permeability is inversely proportional to the thickness of film. The increase in the rate of permeation of H_2 with temperature is shown to be exponential since, when log permeability is plotted against reciprocal of absolute temperature, straight lines are obtained. Various factors regarding the behaviour of coated fabrics are discussed. Moderate amounts of the usual compounding ingredients do not appreciably affect the rate of permeation. The use of highly volatile solvents in spreading cements tends to produce pinholes. Toluol or its equivalent appears to be the most satisfactory solvent.

AUTHORS.

931. Differential Diffusion Constants of HCl and H_2SO_4. W. A. James, E. A. Hollingshead and A. R. Gordon. *J. Chem. Phys.* 7. *pp.* 89–92, *Feb.*, 1939.—The differential diffusion constants of HCl and H_2SO_4 in aqueous solution at 25° C. have been determined with Northrop-McBain diffusion cells. The range of concentration studied was $0{\cdot}01$–$1{\cdot}6$ moles/l. for HCl and $0{\cdot}01$–$1{\cdot}0$ mole/l. for H_2SO_4. The relation previously proposed $k = k_0(1 + c\partial \ln f/\partial c)\cdot(\eta_0/\eta)$ represents the variation of the diffusion constant with concentration reasonably closely, but the values of k_0

required to fit the experimental results are not those predicted by the Nernst relation. [See Abstract 3372 (1937).] AUTHORS.

932. Diffusion in Polished and Etched Copper Surfaces. H. Cramer. *Ann. d. Physik*, 34. 3. *pp.* 237–249, *Feb.*, 1939.—By means of electron diffraction it is shown that polycrystalline layers of Au deposited *in vacuo* on polished or etched Cu substrates and subsequently heated to 150–500° C. change to Au-Cu alloys due to diffusion of the underlying Cu, and that the Cu content increases with temperature. Little or no difference is observed between the polished and etched substrates, and no such effect occurs with Ag layers. Heating of Zn layers to 300° C. resulted in oxidation, but even in this case the diffusion of Cu was so rapid that at 450° C. the surface layers consisted almost entirely of Cu_2O. No rapid diffusion of metal films into polished substrates was observed at room-temperature, and it is suggested that the disappearance of diffractions in similar experiments reported by Finch, Quarrell and Roebuck [see Abstract 3410 1934)] was probably due to the deposition of hydrocarbons. A. G. Q.

See also Abstract 1067.

ELASTICITY AND PLASTICITY.

933. Beam and Plate Problems. J. N. Goodier. *Roy. Soc. Canada, Trans. Sect. III.* 32. *pp.* 65–88, *May*, 1938.—A type of expansion in powers of a thickness parameter, introduced by Synge in his theory of the incompressible elastic membrane, is employed in the derivation of simplified equations for the problems of the thin rod and the thin plate from the general differential equations of elasticity. It is pointed out that the expansion has a property of especial significance in these problems, in that it is capable of representing only such states as involve no local disturbance at the ends of a rod or the edges of a plate. The engineering theories of beams and plates (Bernoulli-Euler and Poisson-Kirchhoff), Saint-Venant's theories of the torsion and bending of cylinders, plane stress and generalised plane stress, are arrived at and extended without making any of the *ad hoc* simplifying assumptions hitherto required, and their characters as approximate or restricted solutions of the general differential equations are made evident. The detailed results are summarised at the end of the paper. AUTHOR.

934. Relaxation Methods Applied to Engineering Problems. Part IV. Problems Relating to Elastic Stability and Vibrations. K. N. E. Bradfield, D. G. Christopherson and R. V. Southwell. *Roy. Soc., Proc.* 169*A*. *pp.* 287–317, *Feb.* 7, 1939.—Preceding papers in this series have been concerned with unique solutions: this paper deals with problems such that a complete solution would define an infinite number of configurations, all satisfying the governing equations and the terminal conditions, but each associated with some particular value of a critical loading or frequency (the "characteristic number" or *Eigenwert*). The strut and vibrating rod (of non-uniform section) have been chosen for detailed treatment as the simplest examples, respectively, of elastic stability and vibrations; but the principles as distinct from the details of the relaxation treatment are quite general, and they provide a new method of attack on problems which are at once difficult and important. In both problems relaxation methods appear capable of determining, with more than sufficient accuracy for practical purposes (when dimensions, etc., are not known exactly), not only character-

istic numbers but also the mode associated with each. (The modes are not determined by the well-known method of Lord Rayleigh.) [For Part III see Abstract 4776 (1938).] AUTHORS.

935. Elastic Properties of Cast Iron. A. I. Krynitsky and C. M. Saeger, Jr. *Bureau of Standards, J. of Research*, 22. *pp.* 191–204, *Feb.*, 1939.—An optical method for measuring the deflection of cast-iron transverse-test bars during loading and up to the breaking strength has been developed. Transverse-strength properties were determined on test bars made from three types of cast iron heated to the maximum temperatures of 1400°, 1500°, 1600 and 1700°. Test bars were vertically cast bottom poured in green-sand moulds at 100°, 150°, 200° and 250° C. above the liquidus temperature. Total, plastic, and elastic deflection ; modulus of rupture ; modulus of relative elasticity ; and total, plastic, and elastic resilience were determined and the microstructure was examined. AUTHORS.

936. Rate of Viscous Flow of Metals. Part II. Lead. L. C. Tyte. *Phys. Soc., Proc.* 51. *pp.* 203–221, *March*, 1939.—Experiments previously reported for tin [see Abstract 950 (1938)] have been extended to lead. It has been found that for very small extensions the velocity of viscous flow v is not completely independent of time. However, as soon as the non-viscous flow ceases to have appreciable effect, the velocity of viscous flow is connected with the stretching load P by an exponential relation for any given temperature and with the absolute temperature T by an exponential relation for any given load. Relationships of the form $v = \delta e^{\beta^{PT-\alpha P+\gamma T}}$, where α, β, γ and δ are constants, have been obtained, from the {flow, load} curves, for the rate of viscous flow of lead, and the relations are probably of the type $v = K\{e^{\beta^{(P+P_0)(T-T_0)}} - 1\}$, where K, β, P_0 and T_0 are constants. Four sets of constants have been obtained, which can be attributed to (1) single or double glide in untwinned crystals, (2) single or double glide in twinned crystals, (3) extension during the recrystallisation period and production of annealing twins and (4) extension when strain hardening is considerably diminished by self-annealing. The elastic limit, transition and breaking loads have been shown to be connected with the corresponding temperatures by hyperbolic expressions. Finally, the general behaviour of the lead wire has been shown to be in agreement with that for tin, and to be in line with the results obtained from single crystals. AUTHOR.

937. Plastics in Industrial Physics. H. W. Melville. *Phys. Soc., Reports*, 5. *pp.* 64–81, 1938.

938. Double Refraction and Change in Length of Plastics. H. W. Farwell. *J. of Applied Physics*, 10. *pp.* 109–113, *Feb.*, 1939.—The change in length of a Vinylite plastic under constant load has been measured, as well as for the succeeding recovery. The change in colour of the light transmitted through crossed Polaroid plates shows large change in the birefringence. The further study is made with uniform length increments at constant temperature using Mach's method to measure the birefringence, both for stretching and recovery. The data are sufficient to give a measure of the dispersion in birefringence and of a Poisson's ratio of 0·50. AUTHOR.

939. Elasticity. H. L. Cox. *Phys. Soc., Reports*, 5. *pp.* 12–19, 1938.

See also Abstracts 923, 1022, 1276.

GRAVITATION.

940. Gravitation and Quanta. J. Solomon. *J. de Physique et le Radium*, 9. *pp.* 479–485, *Nov.*, 1938.—The compatibility of Newton's law with modern gravitational theory is considered critically, and problems arising from the quantisation of the gravitational field and some consequences of Dirac's cosmological theory are discussed. It is concluded that Newton's law and a quantum theory of gravitation can be adapted to the case of weak fields, but for strong fields difficulties arise for which the quantum field theory appears to offer no solution. N. M. B.

941. Quantum Theory of Gravitation. J. Solomon. *Comptes Rendus*, 207. *pp.* 1171–1173, *Dec.* 12, 1938.—A mathematical examination of the bearing of the limitations arising in quantum electromagnetic field theory on the quantum theory of gravitation. N. M. B.

* **942. Oscillations of Elastic Astatic Pendulum. C. F. Baeschlin and A. I. Corpaci.** *Bull. géodésique, No.* 58. *pp.* 133–147, *April-May-June*, 1938.—The work of Lejay and Holweck relating to the period of the elastic astatic pendulum as a function of the amplitude and the error at the start of the movement is re-examined. A correct mathematical analysis of this problem is given. R. S. R.

* **943. Improved Torsion Gravity Meter. F. E. Wright and J. L. England.** *Am. J. Sci.* 35*A*. *pp.* 373–383, 1938.—In the improved instrument the torsion element is the same as that used heretofore, but its other parts have been rearranged to provide simpler control for operation in the field. The present apparatus is lighter than its predecessor and gives promise of even better field performance. The last instrument, during one period of eight months' service in 1937 in occupying and reoccupying old and new gravity stations, yielded results that, for any given station, agreed within one milligal. The new instrument is mounted inside a covered, insulated motor truck. Under ordinary conditions twenty stations or more per day can be occupied. The torsion element in this balance is under load only during the time required to make a gravity measurement (either 4 or 6 min.); otherwise it is at rest and the small residual strains are dissipated. This procedure maintains the characteristics of the spring remarkably constant. Authors.

HYDRODYNAMICS AND AERODYNAMICS.

944. Measurement of Longitudinal and Transverse Turbulent Fluctuations. H. Reichardt. *Zeits. f. angew. Math. u. Mechanik*, 18. *pp.* 358–361, *Dec.*, 1938.—The application of the two-wire and the author's three-wire type of hot-wire anemometer for the determination of longitudinal and transverse fluctuations and heat transfer in non-isotropic turbulent flow is briefly discussed mathematically. Illustrative results are given. J. S. G. T.

945. Frequency Analysis of Turbulent Fluctuations. H. Motzfeld. *Zeits. f. angew. Math. u. Mechanik*, 18. *pp.* 362–365, *Dec.*, 1938.—The analysis of the energy-spectrum of turbulent fluctuations by means of oscillatory systems of frequencies 0·2 to 43 $\sim$ executing torsional oscillations is discussed mathematically. Suitable apparatus is briefly described, and illustrative results, obtained in a wind-tunnel in which the mean velocity of the stream was 100 cm./sec., are in good agreement with results obtained by Simmons and Salter [see Abstract 1433 (1938)]. J. S. G. T.

946. Aerofoil Measurements and Theory of Supporting Surfaces. M. Hansen. *Zeits. f. angew. Math. u. Mechanik*, 18. *pp.* 368–370, *Dec.*, 1938.—Comparison of experimental values of the forces operative upon plane and warped circular surfaces, in an air stream, with theoretical values deduced by means of Kinner's theory (*Ing. Archiv*, 8. *No.* 1, 1937) shows that satisfactory agreement between experimental and theoretical results is found only in certain cases. J. S. G. T.

947. Lift and Drag of a Rectangular Wing Spanning a Free Jet of Circular Section. H. B. Squire. *Phil. Mag.* 27. *pp.* 229–239, *Feb.*, 1939.—Investigations by Glauert and Stüper lead to discordant results for the effect of the jet boundary on the lift and drag of a rectangular wing spanning a free jet of circular section. This problem is solved by an independent method; the results obtained are in agreement with Glauert's results. AUTHOR.

948. Importance of Transition Layer in Helmholtz Theory of Air Waves. Z. Sekera. *Gerlands Beitr. z. Geophys.* 54. 1. *pp.* 9–20, 1938.—A theory developed earlier for wave motion in superposed fluids where velocity increases with height is applied to the extension of Helmholtz's theory of air waves in the case for waves in two superposed fluids separated by a layer of intermediate density in which the velocity varies continuously from the lower to the upper fluid. It is shown that the possible waves representing the singular solution in the theory of three superposed fluids, *i.e.*, waves moving with a wave velocity equal to that of some part of the intermediate fluid, are identical with Helmholtz's air waves. A transcendental equation for their wave-length is obtained. This gives wave-lengths greater than without a transition layer. A graph is given to obtain the factor by which the wave-length without a transition layer must be multiplied to obtain that with such a layer. The factor increases with the ratio, thickness of layer/wave-length, to a maximum of 2·0. Even when the ratio is very small the effect of the transition layer cannot be neglected. As the equation for the wave-length contains terms depending upon the viscosity of the transition layer, this viscosity may be determined from the wave-length of observed air waves, a circumstance showing the great importance of assuming a transition layer in the theory of Helmholtz's air waves. R. S. R.

949. Theory of Vortex Motion. A. Kneschke. *Zeits. f. angew. Math. u. Mechanik*, 18. *pp.* 343–346, *Dec.*, 1938.—Following the method employed by Lagally the equations of motion of a single vortex in a plane, simply connected space filled with fluid are derived; an expression is derived for the kinetic energy in the flow-field of the vortex, and a principle of minimum action enabling the Eulerian equations of motion to be deduced by the calculus of variations is briefly discussed. J. S. G. T.

950. Slow Motion of Fluid. W. R. Dean. *Cambridge Phil. Soc, Proc.* 35. *pp.* 27–43, *Jan.*, 1939.—The slow two-dimensional motion of fluid past an infinite fixed plane, in which there is a gap, is discussed by the method of conformal representation. A simple expression in finite terms is found for the stream function. A partial allowance for the effect of inertia of the fluid is made by proceeding to a second approximation. The part of the stream function corresponding to this approximation is not a biharmonic function, but its most important term near either edge of the gap is biharmonic. Near the edges of the gap the stream function of the motion is biharmonic, however far the process of approximation is continued. The local flow near the edges is therefore of the same general

type as that found from the first two terms of the approximation. The same argument applied to the motion of fluid past an infinite plane having a projection at right angles to the general direction of flow shows that a second approximation should give a closed stream-line or finite vortex near the edge, the area enclosed by the stream-line tending to zero as slow motion is approached. J. S. G. T.

951. Hydrodynamic Forces on an Accelerated Cylinder Moving in Two Dimensions. M. A. Omara. *Phil. Mag.* 27. *pp.* 200–211, *Feb.*, 1939.—In this paper the Blasius contour integral expressions for the determination of the resultant force and moment on a profile in a Joukowski stream are extended to the case of the general uniplanar motion of the profile. The potential function of the fluid motion induced by the motion of the solid is given in the form of a Laurent series, the coefficients of which are expressed in terms of the coefficients of the expansion of the function transforming conformally the exterior of the profile into the exterior of a unit circle. The resultant force and moment are calculated in terms of these coefficients, and the application to the classical case of the ellipse gives well-known results. The consideration of cusped profiles leads to a modification of the generalised Kutta-Joukowski theorem—a modification which is dealt with. Application to the case of a flat plate is given. AUTHOR.

952. Uniform Motion of a Sphere or a Cylinder through a Viscous Liquid. B. R. Seth. *Phil. Mag.* 27. *pp.* 212–220, *Feb.*, 1939.—The assumption of a uniform and symmetric flow has given the following results :—(1) Oseen's criticism of Stokes's solution that it is defective at points distant from the sphere holds good only when the liquid flows past the fixed sphere, and not when the sphere is moving uniformly through it. (2) If the kinetic energy can be infinite it should be possible to use Stokes's solution when U^2/α is too small to be taken into account. (3) When a big sphere moves slowly through a slightly viscous liquid the value of the drag should be at least greater than one and a half times that given by Stokes. In the case of a circular cylinder it should be greater than $4\pi\mu U$. In these cases the Reynolds number, R, has a finite value. (4) As R increases from 0 to ∞ the kinetic energy of the fluid decreases from infinity to the value for the corresponding irrotational motion. (5) For a very big sphere or a cylinder moving slowly through a slightly viscous liquid the motion is everywhere irrotational except in a thin layer near the boundary. R is now very large. AUTHOR.

953. Moving Pictures of Fluid Motion. D. Riabouchinsky. *Comptes Rendus*, 207. *pp.* 1356–1357, *Dec.* 27, 1938.—To aid in the interpretation of theoretical determinations of fluid motion the author has made a film which shows for a number of special problems how the lines of current and the equipotential lines vary with time. Typical frames from the film are reproduced. W. S. S.

954. Flow of Compressible Gas. B. V. Korvin-Kroukovsky. *Frank. Inst., J.* 227. *pp.* 99–110, *Jan.*, 1939.—The relations are derived between velocity, density and pressure in a flowing compressible gas on the basis of fundamental mechanical principles of the conservation of matter, of momentum and of energy. The results are checked by application to test data on the discharge of superheated steam, and are found to be in excellent agreement throughout the range of pressure ratios from 1·00 to 0·20. It is shown that below certain (critical) pressure ratio the polyatomic gas behaves as monatomic, indicating that energy transfers

ceased between rotational and translational motions of molecules. This phenomenon occurs apparently only in accelerating flow, and the change from acceleration to deceleration liberates the temporarily unavailable energy of rotation, and precipitates the sudden increase of pressure, known as "compression shock" in aerodynamics. [See also Abstract 460 (1938).] AUTHOR.

955. Velocity of Front of Jet of Gas. O. Yadoff. *Comptes Rendus*, 208. *pp.* 81–83, *Jan.* 9, 1939.—An electrical method of determining the velocity of the front of a jet of gas is described. The method depends on the rupture, one after the other, of two very thin wires by the jet, and the subsequent discharge of a condenser. A. J. M.

956. Inclined Liquid Jet. J. Satterly and O. A. Gilmore. *Roy. Soc. Canada, Trans. Sect.* III. 32. *pp.* 17–27, *May*, 1938.—Measurements on the profile of a jet by a photographic method have been continued [see Abstract 1436 (1938)]. Both ascending and descending portions of the jet are parabolic but not parts of the same parabola; the downward portion has a longer range than the upward. The range of the jet is shorter and the elevation less than the calculated values owing to air resistance. The pressures within the jet are approximately equal to atmospheric pressure in the upward portion and less in the downward portion of the jet. Velocities calculated from the flow and cross-sectional area agreed with values obtained from a Pitot tube. J. B. W.

See also Abstract 1061.

KINETIC THEORY OF MATTER.

957. Excitation of Molecular Vibrations by Collision. A. Eucken and L. Küchler. *Zeits. f. techn. Physik*, 19. 12. *pp.* 517–521, 1938.—It is recalled that from measurements of the dispersion of h.f. sound in gases the number of collisions which result in a transition of vibrational energy to translational energy can be obtained. Earlier determinations of this collision number Z^* in different pure gases and gas mixtures are tabulated. The authors' determinations of Z^* for CO_2 and N_2O with admixtures of other gases are given for temperatures of 293 and 673° K. A qualitative explanation of these results is given by means of a theory involving the potential curves of the molecules. K. M. C.

958. Influence of Interaction of more than two Molecules on Molecular Distribution Function in Compressed Gases. J. de Boer and A. Michels. *Physica*, 6. *pp.* 97–114, *Feb.*, 1939. *In English.*—Starting from the usual expression for the molecular distribution function $g(r)$, a series expansion into powers of $1/v$ is given. The second approximation has been evaluated numerically for a Lennard-Jones potential field in the revised form $V(r) = 4\epsilon(R^{-12} - R^{-6})$ (where $R = r/\sigma$), which allows the results to be applied to all gases, for which the molecular field constants are known. The results obtained are compared with the experimental curves for liquid Hg, Ga and K and the general behaviour is interpreted, using the relations between $g(r)$ and the potential of the mean force acting between two molecules. Finally, using the virial theorem and the calculated $g(r)$ values, the third virial coefficient has been evaluated theoretically, the results being compared with the experimental figures for N_2 and A. AUTHORS.

959. Effect of Electric Field on Oxygen Atoms and Water Molecules in Molecular Beam Experiments. H. Scheffers. *Phys. Zeits.* 40. *pp.* 1–13, *Jan.* 1, 1939.—Previous work on the influence of strong electric fields on H atoms in atomic beam experiments [see Abstract 2543 (1936)] are extended to O atoms and H_2O molecules. The atomic O is generated by electrodeless discharge and registered by its action on a warmed plate covered with PbO. Unilateral deflection in an electric field is observed, the polarisability of the O atom being smaller ($0{\cdot}2 \times 10^{-24}$ cm^3.) than that of H. The molecular beam of H_2O is registered on a cooled Ni plate and the trace is developed by Hg vapour. In accordance with expectation, on account of the permanent moment of H_2O, large symmetrical deflection to both sides is observed (photograph reproduced). L. A. W.

960. Brownian Motion. R. C. Brown. *Phys. Soc., Reports,* 5. *pp.* 9–11, 1938.

961. Brownian Motion and Geometrical Schemes. P. Lévy. *Comptes Rendus,* 207. *pp.* 1152–1154, *Dec.* 12, 1938.—A general scheme is outlined which gives a conception of Brownian motion. The limitations of the scheme are described, and methods are given which provide a conception and measure of Brownian agitation. R. S. R.

See also Abstracts 954, 1295.

LENGTH, AREA AND VOLUME.

962. Determination of Internal Volume of Steel Capillaries for Measurements with Gases. J. Kaminsky and B. E. Blaisdell. *Rev. Sci. Instruments,* 10. *pp.* 57–58, *Feb.*, 1939.—Two known methods for measuring the internal volume of steel capillaries were compared. The volume obtained from the mass and density of Hg contained was from 3 to 6% smaller than that determined by the gas expansion method. The latter is the correct volume to be used for measurements with gases. AUTHORS.

MASS.

See Abstracts 971, 997, 1202.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

963. Principles of a New Technique of the Method of Least Squares. T. Banachiewicz. *Acad. Polonaise Sci. et Lettres, Bull.* 3–5*A*. *pp.* 134–135, *March–May,* 1938. *In French.*

964. Numerical Calculation of a Generalised Complete Elliptic Integral. W. Bartky. *Rev. Modern Physics,* 10. *pp.* 264–269, *Oct.*, 1938.

965. Wave-Motion for Sub-Infinite Domains. A. N. Lowan. *Phil. Mag.* 27. *pp.* 182–194, *Feb.*, 1939. [See also Abstract 3948 (1938).]

See also Abstracts 934, 1349.

MECHANICS, CLASSICAL.

966. Maximum Projectile Velocities Attainable with Modern Propellent Powders. H. Langweiler. *Zeits. f. techn. Physik,* 19. 11. *pp.* 416–421, 1938.—In the absence of an exact solution of Lagrange's problem the maximum attainable velocity cannot be accurately determined

but by making wide simplifying assumptions various theories have been developed which lead to values between 1600 m./sec. and 8000 m./sec. By application of the theory of expansion of gases through nozzles a limiting value of 2810 m./sec. is calculated assuming an infinitely high ratio of powder to shot mass and an infinitely long barrel. Experiments with nitrocellulose for a gas pressure of 12600 kg./cm^2. and under conditions approximating to the theoretical assumptions gave a value of 2790 m./sec. in good agreement with theory. From the experiments the relation between Séberts factor and the nozzle velocity is determined. Introduction of detonating processes permits increase of the limiting velocity to 3800 m./sec. for nitrocellulose powder and to 6000–7000 m./sec. for the most energetic propellents. J. E. K.

967. Gyroscopic Movement of Projectiles. P. d'Adhémar. *Ann. Soc. Sci. de Bruxelles*, 58. *pp.* 42–64, *March* 19 ; 124–142, *June* 24, *and pp.* 172–210, *Dec.* 12, 1938.—Theories developed earlier [see Abstract 1461 (1938)] have been reexamined in an attempt to justify certain hypotheses but after consideration it was necessary to return to generally admitted conceptions and methods of approximation which appear to be correct. The development of the theory is based on surmises since the projectile moves in a fluid whose properties are imperfectly known. The study of a minimum near zero of the scale, in a rotatory motion is completed and earlier results are confirmed. Initial perturbations are examined and an attempt is made to give greater precision. It is suggested that some terms in the vocabulary of this science are ill-chosen and are sometimes employed with different meanings. R. S. R.

968. Ballistic Method for Bomb Projection. C. Yamauchi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 848. *pp.* 1409–1421, *Oct.*, 1938. *In German.*—The paper reviews the mathematical basis of tables for determination of the ballistic factors concerned with the flight path of a projectile and in particular takes into account variations in air density and also air resistance according to the Charbonnier and Euler-Otto equations. S. G. B.

969. Stable Orbits of Reduced 3-Body Problem. A. Datzeff. *Comptes Rendus*, 207. *pp.* 977–979, *Nov.* 21, 1938.—Two particles with opposite charges and a neutral one move under the influence of their electric and gravitational interactions in such a manner that the neutral particle and the negatively charged one are very closely together, whereas the positive particle is at a greater distance. The orbits are approximately calculated. By imposing a certain condition on the frequencies a set of frequencies can be selected which are equal to those of the H atom. R. P.

970. Singular Points in Restricted 3-Body Problem. D. Belorizky. *Comptes Rendus*, 207. *pp.* 1382–1384, *Dec.* 27, 1938.—The binary collisions in this problem are discussed using Levi-Civita's contact-transformation, with a view to discovering collisions with imaginary co-ordinates. It turns out that such collisions occur at points which are critical algebraic points of order 4. A further analysis shows that, in the restricted 3-body problem, there are no singularities in the finite part of the plane other than critical algebraic ones. G. C. McV.

971. Definition and Determination of Mass in Newtonian Mechanics. C. G. Pendse. *Phil. Mag.* 27. *pp.* 51–61, *Jan.*, 1939.—The problem of the definition and determination of mass in Newtonian mechanics was discussed in a previous paper [see Abstract 5218 (1937)].

Mach's definition of the ratio of the masses of two bodies was shown to be applicable to the case of two bodies forming an "isolated" system, but that this definition does not enable an observer to determine the ratio when the system is composed of more than four or sometimes seven particles. The investigation is extended in the present publication; it is shown that the ratio of the masses as defined by Mach, does not have the same constant value for all observers. Confining attention to one frame of reference and an observer fixed in it, two aspects of the problem of the determination of mass are examined. C. J. B. C.

See also Abstracts 882, 1302, 1311, 1350.

MECHANICS, QUANTUM.

972. Interaction between Elementary Particles. E. C. G. Stueckelberg. *Comptes Rendus*, 207. *pp.* 387–389, *Aug.* 17, 1938.—On the face of it it might appear from the usual calculations on nuclear forces that these would only apply to free particles. It is shown that one is justified in taking the same expressions for the interaction forces as a basis for calculations of binding energies. R. P.

973. Partitio Numerorum in Nuclear Physics. K. Husimi. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 912–925, *Nov.*, 1938. *In English.*—If a nucleus is idealised as a system having vibratory degrees of freedom with equally spaced frequency values, the problem of finding the mean number of excited degrees of freedom for a given total energy reduces to a mathematical problem about the *partitio numerorum*, of which a solution is given. This does not confirm a conjecture as regards the asymptotic formula, which was made by Umeda [see Abstract 4053 (1938)]. R. P.

974. Reciprocity. M. Born. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 309–314. *Nov.*, 1938.—The difficulties associated with the theories of light and of the nature of the ultimate particles of matter, *viz.*: the existence of infinite self-energies of the particles, are discussed. A solution can only be found in terms of non-linear field theories and the most natural way of achieving such a theory would be by the introduction of curvature. The author suggests the use of a curved "momentum-space" and shows how it is connected with an appropriate parallel displacement. One consequence is that the components of momentum for a particle with vectorial wave-function do not, in general, commute. The theory suggests the possibility of introducing an absolute momentum and an absolute length separately into theoretical physics and not merely their product in the form of Planck's constant h. G. C. McV.

975. Potential Barriers and the Solution of Schrödinger's Equation. A. Datzeff. *Ann. de Physique*, 10. *pp.* 583–673, *Dec.*, 1938.

976. Wave Mechanics of the Heavy Electron. J. Géhéniau. *Comptes Rendus*, 207. *pp.* 1173–1175, *Dec.* 12, 1938.—From the analogy of the heavy electron to the photon, a wave mechanics is formulated for the heavy electron on the basis of the de Broglie photon mechanics. The electric current-density vector and proper magnetic moment are examined. N. M. B.

977. Perturbation by Boundary Deformation as a Problem of Proper Values. N. Cabrera. *Comptes Rendus*, 207. *pp.* 1175–1177, *Dec.* 12, 1938.—Results obtained by Brillouin [see Abstract 3912 (1937)] by an alternative method are obtained directly. N. M. B.

978. Difficulties and Developments in Quantum Mechanics. H. T. Flint. *Phys. Soc., Reports*, 5. *pp.* 402–421, 1938.

979. Quantum Theory and Wave Mechanics. Part II. G. Wentzel. *Die Physik*, 7. 1. *pp.* 1–12, 1939.—Continuing Part I of this paper [see Abstract 4877 (1934)] the author gives an account of the present position of the quantum theory and wave mechanics. In particular he deals with the spontaneous energy problem and the various unitary theories. On the question of the theory of pair particles, the hole theory of the positron receives particular attention. More than half of the paper is devoted to nuclear physics; points specially discussed being the theory of nuclear construction and nuclear processes, the field theory of nuclear forces and the theory of β decay. The list of references is particularly comprehensive. G. O. B.

980. Two-Centre Problem in Wave Mechanics. Part I. Hyperbolic Nodes of Wave Equation. P. E. Marrack. *Cambridge Phil. Soc., Proc.* 35. *pp.* 44–55, *Jan.*, 1939.—Approximate expressions are obtained, when the distance R between the nuclei is very large, for that portion of the wave function in the two-centre problem which depends on the hyperbolic coordinate μ. From these expressions the number and the approximate position of the nodes in μ can be deduced and hence the rules can be found by which that state of the combined atom at $R = 0$ can be determined which corresponds to a given state of the atom when the nuclei are completely separated. These rules are also applicable to the cases where the two atoms which can be formed when the nuclei are completely separated have the same energy. The converse problem of finding what state of the completely separated atom corresponds to a given state of the combined atom at $R = 0$ can also be solved by the use of the rules. AUTHOR.

981. Representation of Eddington's E-Numbers. W. H. McCrea. *Cambridge Phil. Soc., Proc.* 35. *pp.* 123–125, *Jan.*, 1939.—A matrix with sixteen rows and columns is given which represents one of Eddington's E-numbers. The representation has the property that two E-numbers can be added, subtracted or multiplied in a given order by performing the corresponding operations on their matrix representatives. G. C. McV.

982. Three Elementary Examples of the Uncertainty Principle. D. S. Kothari. *Phil. Mag.* 27. *pp.* 62–67, *Jan.*, 1939.—The uncertainty principle states the inherent limitation on the possibilities of observations of the states of atomic particles. There are a number of illustrative examples in the literature, and the present note deals with three examples which have not previously been discussed: (1) the microscope and its depth of focus as applied to an observation on a particle such as an electron; (2) the measurement of an angle and angular momentum; (3) the measurement of the velocity of a particle by the method of moving slits. C. J. B. C.

983. Force-Free Particles with Any Spin. M. Fierz. *Helv. Phys. Acta*, 12. 1. *pp.* 3–37, 1939. *In German.*—In dealing with force-free cases it is possible to devise quantised wave fields which describe particles having whole-number or half-number spins greater than one. It is shown that particles with whole-number spins must obey Bose statistics, while those with half-number spins obey the Fermi-Dirac statistics. The wave fields with spins smaller than or equal to one are already distinguished in

force-free cases by the fact that for them the charge density and the energy density are uniquely determined and invariant quantities, while in the cases of higher spins this only holds for the total charge and the total energy. G. O. B.

984. Geometric Derivation of Second-Order Wave Equation. H. W. Haskey. *Phil. Mag.* 27. *pp.* 221–227, *Feb.*, 1939.—The second order wave equation is made equivalent to one which is a gauging equation and the function ψ appears as a gauging function or scale-factor. This supports the suggestion that the quantum theory is to be regarded as the expression of the fact that a particular space metric belongs to the physical world. It would appear that the idea of Weyl and Eddington has been applied in the wrong place in physics—the metric is not to be traced in electromagnetic phenomena, but in the finer world-structure that the quantum theory describes. This view accords well with the new character of Planck's quantum of action which the later form of the quantum theory applies to it. AUTHOR.

See also Abstracts 883, 940, 941, 965, 1165, 1197, 1291, 1364, 1365, 1369, 1370.

PHILOSOPHY OF SCIENTIFIC METHOD.

985. Intuition, Reason and Faith in Science. G. D. Birkhoff. *Science*, 88. *pp.* 601–609, *Dec.* 30, 1938. *Nature*, 143. *pp.* 60–67, *Jan.* 14, 1939. *Supplement.*—Science is now generally recognised as the main source of revelation, but so much remains incomprehensible that an unjustified attitude of discouragement and loss of faith is sometimes found. According to the author, whether the universe is conceived as being objective or subjective, there appear to be five ascending levels, *viz.*, mathematical, physical, biological, psychological and social—each with its own concepts and language and one is not to be regarded as being more real than the others. To understand facts and their relations it is necessary to employ abstractions which are however applicable only within definite limits, and the approach to a better understanding is only to be made through a widening succession of abstract ideas. Articles of faith such as the foregoing inevitably arise in the mind of a scientist in his attempt to theorise with respect to his results and in discussing this phenomenon of faith some of the fundamental aspects of present day science are considered and problems are cited from the five hierarchic levels which illustrate the parts played by intuition, reason and faith in scientific progress. The subjects briefly mentioned are, in mathematics, the study of the existence of infinite classes and self-consistency ; in physics, the development of the electromagnetic and the quantum theories ; in biology, the concept of the organism and its evolution ; in psychology, the physiological reactions to psychical phenomena, and in sociology the idea of social progress. Finally, certain conclusions are indicated as follows: Intuition and reason are the common property of all competent individuals, but the close deductive reasoning of the earlier levels is replaced by loose webs of inductive reasoning at higher levels. At the same time the simple basic intuitions of the former change into the complex forms characteristic of the latter, but systematic reasoning is always necessary to eliminate biassed views. Along with the expansion of scientific knowledge beliefs also arise which constitute the aura of faith which makes the most powerful incentive to further progress. A. M. T.

See also Abstract 1421.

PRESSURE.

***986. Simple Form of Knudsen Manometer. S. Werner.** *Zeits. f. techn. Physik*, 20. 1. *pp.* 13–16, 1938.—Full details are given for the construction and use of a simple type of Knudsen manometer, the calibration of which is based on first principles and does not involve the use of a McLeod gauge. As in the original Knudsen manometer, the instrumental deflections are directly proportional to pressure and are independent of the nature of the gas at pressures below 2μ; a further advantage is that instantaneous readings of pressure are given. The measuring range extends from 1 mm. down to 1×10^{-8} mm., and the accuracy attained is ample for general purposes. H. B.

***987. Spherical Ground Joints for Vacuum Systems. S. M. Rubens and J. E. Henderson.** *Rev. Sci. Instruments*, 10. *pp.* 49–50, *Feb.*, 1939.

See also Abstracts 1202 and
509B. Application of Metal Tube in Measuring a Vacuum. T. A. Rogers, B. L. Robertson and D. D. Davis.

RELATIVITY AND ETHER.

988. Definition of Force in Special Relativity. E. Esclangon. *Comptes Rendus*, 208. *pp.* 62–65, *Jan.* 9, 1939.—By considering the projection of the velocity of a moving particle on a plane normal to its acceleration, an invariant under Lorentz transformations is established. Using this result it is possible to write down equations of motion, invariant under Lorentz transformations, in such a way that the force-vector has a constant value for these transformations. G. C. McV.

989. Einstein and Bergmann's New Unitary Field Theory. K. Yano. *Imp. Acad. Tokyo, Proc.* 14. *pp.* 325–332, *Nov.*, 1938. *In French.*—A new unitary field-theory proposed by Einstein and Bergmann is shown to be a particular case of the five dimensional Riemannian geometries in which a non-integrable relation exists between the differentials of the coordinates. If the relation is $A_i dx^i = 0$, then a coordinate transformation $x'^i = x^{-i} + A_i dx^i$ is, by hypothesis, such that the metric of the space remains invariant under the transformation. G. C. McV.

990. Relativistic Generalisations of the Fundamental Equations of Analytical Mechanics. B. Kwal. *Comptes Rendus*, 208. *pp.* 162–164, *Jan.* 16, 1939.—Results previously reported are modified [see Abstract 548 (1939)], and the canonical equations of the photon field and mesotron field and of the electromagnetic field are developed. N. M. B.

991. Group Theory and Kinematical Relativity. W. H. McCrea. *Roy. Irish Acad., Proc.* 45*A*. 2. *pp.* 23–30, 1938.—The results of kinematical relativity can be obtained by means of group theory. Thus it is shown that the chief properties of linear systems of equivalent observers are consequences of the one-parameter group which transforms the signal-functions. Milne's three dimensional theory of equivalent observers is greatly simplified by the use of the Lorentz-group and the acceleration-formula can be rapidly obtained by this method. It is shown that, in Milne's scheme, only two Lorentz invariants exist between the time-variable, the three space-variables and the three velocity-components owing to the restriction that the velocity must be parallel to the radius-vector from the origin. G. C. McV.

992. Macroscopic Theory of Fields of Force. J. Mariani. *J. de Physique et le Radium*, 10. *pp.* 32–38, *Jan.*, 1939.—The author rejects the hypothesis that space-time structure is connected with the material content of space-time and takes the geometrisation of dynamics, based on invariance under contact-transformations, as the foundation of the geometrisation of the physical universe. In particular, he regards the recession of the nebulæ as independent of the nature of space-time and adopts Euclidean space. He then establishes the group of contact-transformations which ensure that the motion of the nebulæ is such that they appear to be receding in all directions from an observer on any one of them. The theory can also be extended to include the case of accelerated particles and leads to a particular case of the accelerated particles of E. A. Milne's kinematical relativity. G. C. McV.

See also Abstracts 940, 941, 974, 984, 1121.

SOLUTION.

993. Influence of Organic Solvents on High-Molecular Materials. W. L. H. Moll. *Kolloid Zeits.* 86. *pp.* 1–74, *Jan.* 6, 1939.—In all, 17 high-molecular materials, *e.g.*, polystyrene, cellulose derivatives, etc., and 64 organic solvents are investigated. It is shown that from a knowledge of the surface tension, dipole moment and dielectric constant of the solvent it can be estimated whether or not a high-molecular material will dissolve or swell in the solvent. From measurements of the dielectric polarisation, the solvation of the high-molecular material is estimated, cellulose derivatives for example having solvation numbers of 1 to 3 molecules for each C_6-content. The conclusion drawn from this and previous work by various authors is that the process of swelling and dissolving of high-molecular materials in organic solvents consists essentially in the formation of stoichiometric solvates. E. R.

994. Freezing-Point–Solubility Curves of Hydrates and Other Compounds under Pressure. L. H. Adams. *Am. J. Sci.* 35*A*. *pp.* 1–18, 1938.—For the determination of equilibrium in systems under high pressure there are two principal modes of attack. We may either devise an experimental method for measuring directly the solubility at the various pressures, or determine indirectly the variation of concentration with pressure under conditions of equilibrium by measuring the compressibilities of the several phases and applying a simple thermodynamic relation. It has already been shown by the author that for simple systems under pressures of several thousand bars (metric atmospheres) the indirect thermodynamic method is convenient and precise. Equilibrium curves for more complex cases, in which hydrates and other compounds appear, are now considered in detail and the various equations used in passing from volume-change measurements to points on the freezing-point–solubility curves are set forth. The method is illustrated by the determination of the solubility curve of a salt hydrate under pressure, and other representative types of equilibrium diagrams are discussed. AUTHOR.

995. Solubility of Water in Benzene Solutions of Ethanolamine Oleate. R. C. Pink. *Chem. Soc., J. pp.* 53–55, *Jan.*, 1939.—Solutions of ethanolamine oleate in benzene and other organic solvents dissolve relatively large amounts of water. The absorption of the water is accompanied by a rise in the viscosity of the system. Small quantities of various

phenols increase the amounts of water taken up to a remarkable extent. [See also Abstract 4287 (1938).] AUTHOR.

996. Solubility of $PbSO_4$ in Solutions of H_2SO_4. D. N. Craig and G. W. Vinal. *Bureau of Standards, J. of Research*, 22. *pp.* 55–70, *Jan.*, 1939.—New determinations of the solubility of $PbSO_4$ in H_2SO_4 solutions have been made, using diphenylthiocarbazone, commonly called dithizone, as the reagent. This provides a very sensitive method for small quantities of lead. The equivalence point was detected by a simple arrangement of a photronic cell and colour filter. The range of concentrations of acid extended from 0·1 to 50% H_2SO_4. Determinations of the lead could be made with an average error not exceeding 0·7 μgm. Determinations were made at 25° and 0° C., employing solutions, some of which were brought to saturation equilibrium from undersaturation and others from supersaturation. Important maxima and minima in the solubility curves which had not been reported previously were found. Tables are given for the solubility of the salt at 25° and 0° C. Comparison is made of the effect of H_2SO_4 on the solubility of $PbSO_4$ and Hg_2SO_4. The trend of the curves for these is strikingly similar, although the latter is more than 80 times as soluble. AUTHORS.

See also Abstracts 894, 898, 899, 1249, 1362.

SURFACE PROPERTIES.

***997. New Technique for Measurement of Adsorption of Gases and Vapours on Solids. H. H. Chambers and A. King.** *Chem. Soc., J. pp.* 139–143, *Jan.*, 1939.—A new technique, capable of detecting very small changes of adsorption by a direct-reading, floating balance method, is described. The advantages of this method over others in common use are discussed, and applications suggested. AUTHORS.

998. Gibbs' Adsorption Theorem. Anomalies in Applying it to Surface Tension Curves that Exhibit Minima in Dilute Solution. J. W. McBain and G. F. Mills. *Phys. Soc., Reports*, 5. *pp.* 30–45, 1938.

999. Sorption of Long-Chain Aliphatic Compounds from Surface Films by Solid Disperse Phase. A. Achmatov. *Acta Physicochimica*, 9. 1. *pp.* 51–88, 1938. *In English.*—A method of measuring the sorption of fatty acids (C_{14}–C_{18}) by charcoal by means of the two-dimensional pressure exerted by a film on a water surface is described. The rate of sorption is considerably higher than for lower members in the fatty acid series. A sorption isotherm has been obtained for the absorption of oleic acid (C_{18}) and myristic acid by charcoal, and the applicability of Langmuir's absorption equation proved. The volume solubility of the surface films of fatty acids is proportional to the two-dimensional pressure. The sorption of fatty acids by crystalline sulphur and talc has also been measured, and it is shown that a mineral acid HCl undergoes sorption simultaneously with the organic acid. F. J. L.

1000. Two Definitions of Surface Tension. L. Brillouin. *J. de Physique et le Radium*, 9. *pp.* 462–464, *Nov.*, 1938.—The author points out that surface tension may be defined in two ways which are not strictly identical. In one form a body of liquid is supposed to have its surface S increased by a small increment, the point to note being that the total material in the surface is in this case allowed to increase at the expense of the body of the liquid. In the other case a thin rectangular film is assumed to be supported on a wire frame and the surface increased by

a small movement of one side of the film. Here the total material in the surface is not increased, and the surface tension is dependent on the movement given to the side of the film just as if it were a piece of stretched rubber. F. S. B.

1001. Surface Tension. R. C. Brown. *Phys. Soc., Reports*, 5. *pp.* 1–9, 1938.

1002. Surface Tension of Hydrocarbons. D. L. Katz and W. Saltman. *Indust. and Engin. Chem.* 31. *pp.* 91–94, *Jan.*, 1939.—Data on surface tension of saturated ethane, propane, and *n*-butane in the range of 0° to 45° C. are presented. These data and those in the literature are correlated by means of a general curve for surface tension of normal paraffins as a function of reduced temperature. A discussion of the possibility of using surface tension measurements as criteria for critical temperatures of petroleum hydrocarbons is included. AUTHORS.

1003. Optical Investigation of Oxide Films on Metals. C. E. Leberknight and B. Lustman. *J.O.S.A.* 29. *pp.* 59–66, *Feb.*, 1939.—Observations were made on the ellipticity resulting when plane-polarised light was reflected from iron and nickel surfaces covered with oxide films continuously increasing in thickness through the temper-colour range. It was found that the results could be interpreted by the assumption of multiple reflections occurring within the film. The method permits a determination of the thickness and average optical properties of the film and may apparently be applied to the accurate measurement of the rate of formation of a film of any composition on a metal surface through the temper-colour range. The index of refraction of the film on iron was found to be complex and to have the value $2 \cdot 13 - i \cdot 41$. The optical constants of pure iron were also found to vary with temperature in such a manner that n in the expression $n(1 - ix)$ increased with increasing temperature, while x decreased. It is further shown that the assumption of multiple reflections within the film gives the same results for thin films as the Drude transition layer theory. AUTHORS.

1004. Atmospheric Oxidation of Metals and Alloys. M. Bound and D. A. Richards. *Phys. Soc., Proc.* 51. *pp.* 256–266, *March*, 1939.—The atmospheric oxidation of evaporated films of a number of alloys and metals has been studied by electron-diffraction at various temperatures. In a number of cases the protective oxide film formed at room-temperatures was not detected even after a month's exposure to air, but in other cases evidence for the oxidation of the metal at room temperatures was obtained. AUTHORS.

1005. Built-Up Films of Esters. E. Stenhagen. *Faraday Soc., Trans.* 34. *pp.* 1328–1337, *Nov.*, 1938.—The type of deposition of ester films is nearly independent of the substrate, but depends on the piston pressure used. If the alkyl chain does not contain more than five C atoms it lies flat in the surface in the expanded film, but is forced on compression down into the water and attains a vertical orientation opposing the long chain. If it is less than three C atoms the films are, at higher pressures, condensed with the short chain in a vertical position, but when it is longer the films tend to be expanded and collapse on compression before the short chain has attained a vertical position, and when it is very long lateral adhesion makes the molecule orientate itself like a hairpin on the surface. It has been found impossible to build up multilayers of esters in which the short alkyl chain is longer than two C atoms. α, α'- and α, β-dipalmitin give solid monolayers on water and can be built into multilayers from a

pure distilled water substrate, and these have been shown by means of X-rays to be of the double sheet type having a long spacing of *ca.* 46 Å. Octadecyl acetate built-up films exist in two modifications, stable α and β, tilted double sheet form. The thickness of the ester multilayers is measured optically by comparison of interference colours, and in the case of ethyl stearate and octadecyl acetate it is nearly the same as the vertical lengths of the molecules as determined by X-rays. Built up films are hydrophobic, the X-ray pattern of methyl stearate is unchanged after immersion for 30 hr. in *N* NaOH at room-temperature. The contact potentials have also been measured. F. J. L.

1006. Use of Monolayer Measurements for Determining Structures in Aqueous Media. A. E. Alexander. *Chem. Soc., J. pp.* 177–181, *Jan.*, 1939.—The study of monolayers of long-chain esters and of α-triazopalmitic acid has shown that both the ester and the triazo-group, which normally exist in a resonating state, lose this resonance on immersion in water and revert to one definite form. With the former it is to the classical structure $R - C\begin{matrix}\diagup\!\!=O\\ \diagdown\!\!-O\end{matrix}R'$ with practically free rotation about the C — O bond, and with the latter, to the coordinated form $-N \leftarrow N \equiv N$. Author.

1007. Electrical Properties of Deposited Layers of Calcium Stearate. P. A. Zahl, C. P Haskins, D. M. Gallagher and C. E. Buchwald. *Faraday Soc., Trans.* 35. *pp.* 308–312, *Feb.*, 1939.—A description is given of an apparatus and method for the determination of the resistance and capacitance for groups of monolayers of some of the alkali stearates, in the presence of an electrolyte consisting of the water solution of a metal salt, and results are presented. Some advantages and disadvantages of the method are pointed out. Among the latter, the fact is emphasised that films of the alkali stearates may be electrically modified by water solutions of various metallic salts, rendering these data incomparable with those obtained by the mercury-droplet method of Race and Reynolds. Authors.

***1008. Film Balances and Ordinary Liquid Surfaces. J. W. McBain and L. H. Perry.** *Indust. and Engin. Chem.* 31. *pp.* 35–39, *Jan.*, 1939.—Describes some of the ways in which the film balance may be used in studying the surfaces of ordinary solutions, classifies such surfaces according to their behaviour, and gives typical results. Evidence for considerable depth in the surface is indicated. P. H. B.

See also Abstracts 903, 908, 932, 1011, 1012, 1013, 1020, 1284, 1285, 1375 and 448B. Theory of Lubrication. Part III. M. Muskat and F. Morgan.

TIME.

1009. Graphical Representation of Transit Observations. A. Gougenheim. *Bull. géodésique, No.* 58. *pp.* 158–189, *April-May-June*, 1938.—Considering analytically the classical formulæ for the reduction of meridian circle observations, the author derives an analogous graphical method of representation. Determinations of time at the transit circle are considered as determinations of position made by a fictitious observer at one of the poles of the geographical meridian of observation, noting transits at a zenith distance of 90°. So treated, the method becomes analogous to Claude and Driencourt's reduction of equal altitude observations with the prism

astrolabe. The advantages of the graphical method over the analytical are outlined, and its power in suggesting new methods of observation is illustrated. Certain methods, not yet in current use, which are designed to avoid instrumental errors of observation, are discussed. Four numerical examples illustrate the graphical method. A. Hu.

See also Abstract 900.

VISCOSITY AND FRICTION.

1010. Rotation of Cylinder in Viscous Liquid. Part III. T. Sakurai. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 997–1008, *Dec.*, 1938. *In English.*—An expression is developed for the stream function representing the motion of a viscous fluid contained between an outer cylinder and a parallel inner one which rotates slowly, steadily, and slightly eccentrically, about the axle of the outer cylinder. [See Abstract 146 (1939) and *ibid.* 20. *p.* 963, *Nov.*, 1938.] P. H. B.

1011. Intermolecular Forces in Liquid Systems. Parts I and II. S. T. Bowden and E. T. Butler. *Chem. Soc., J. pp.* 75–83, *Jan.*, 1939.—Although the organic carbonates are stable and easy to purify, the data relating to their physical properties are extremely meagre. The authors have determined the ebullioscopic constant of methyl carbonate, and the density, refractive index, viscosity, surface tension, and parachor of the *n*- and the *iso*-derivatives of the series. It is shown that these liquid carbonates have the non-polar structure in which the central C atom has a normal octet. From the standpoint of homology the series offers interesting features with respect to the boiling point, viscosity, and parachor relationships. The direct preparation of *n*-hexyl carbonate from sodium hexoxide and carbonyl chloride is described. In Part II the properties of systems containing methyl or ethyl carbonate and non-polar and dipolar liquids have been studied with a view to ascertain the nature of the intermolecular forces. Errera's rules connecting the type of viscosity–concentration curve with the dipole moments of the components are found to apply to all the systems investigated except those containing nitrobenzene. The surface tension–composition curves for the mixtures are negative, and show a minimum corresponding to identity of the surface and the bulk phase in the cases of methyl carbonate–benzene, ethyl carbonate–chloroform, and ethyl carbonate–carbon tetrachloride. No obvious relationship exists between the surface adsorption and the dipole moments of the components. The parachor of the alkyl carbonate preserves a constant value in all the systems except those containing nitrobenzene, where the solute parachor increases with the concentration. It is shown that liquid mixtures may be classified into three types according as the parachor–concentration curve is (*a*) a horizontal line, (*b*) a straight line rising with the solute concentration, and (*c*) a curve showing a non-linear relationship between parachor and concentration. Under suitable conditions, the parachor of the solute in non-polar and dipolar systems can be found by extrapolation with an accuracy of 1%. Authors.

1012. Theory of Viscous Flow Reactions for Chain-Like Molecular Substances. F. Eirich and R. Simha. *J. Chem. Phys.* 7. *pp.* 116–121, *Feb.*, 1939.—Ewell and Eyring [see Abstract 4377 (1937)] investigated a relation for the coefficient of internal friction as a reciprocal reaction rate employing a large number of data. In this paper these investigations are extended to new data involving homologous series of

higher esters. The variation of the activation heats of the flow process with temperature, molecular weight, and constitution, is considered and an attempt made to correlate it to the molecular constitution. There are indications that the above-mentioned ideas contain implicitly through Stefan's theorem a relation between surface tension and viscosity.

AUTHORS.

1013. Viscosity in Expanding Bubble. E. C. Westerfield and W. B. Pietenpol. *Phys. Rev.* 55. *pp.* 306–307, *Feb.* 1, 1939.—The rate of doing work per unit volume in a homogeneous medium is shown to be $dw/dt = \nabla\ (\mathrm{v} : \psi)$ where v is the velocity vector and ψ the stress dyadic. For an incompressible fluid this becomes $dw/dt = 2\mu\ \phi : \phi + (\rho/2)dv^2/dt$, where μ is the coefficient of viscosity, ϕ the symmetric rate of strain dyadic and ρ the mass density. From this relation, it is shown that the pressure difference between the inside and outside of a steadily expanding bubble composed of an incompressible viscous fluid, is given by $p_1 - p_2 = 2\gamma(r_1^{-1} + r_2^{-1}) + 4\mu K(r_1^{-3} - r_2^{-3})$ where γ is the surface tension, r_1 and r_2 the inner and outer radii of the bubble, respectively, and K is the expansion constant r^2v for any point in the material of the bubble.

AUTHORS.

1014. Viscosity of Non-Newtonian Fluids. C. F. Goodeve. *Phys. Soc., Reports*, 5. *pp.* 20–29, 1938.

1015. Viscosity of Oxygen at Low Pressures and in a Magnetic Field. A. van Itterbeek and A. Claes. *J. de Physique et le Radium*, 9. *pp.* 457–461, *Nov.*, 1938.—Using Maxwell's oscillation method the authors have determined the variations of viscosity of O_2 with magnetic field (intensity maximum 869 oersted, lines of force perpendicular to the movement of the gas) and with pressure (range 760 mm. to 0·5 mm.) at room-temperature and at 90° Abs. The results in general are in agreement with those obtained by the capillary flow method in that the viscosity diminishes under the influence of the field. At room-temperature this diminution passes through a maximum at about 15 mm. This appears to be a definite property of O_2 since it is independent of the experimental method used. At 90° Abs. no reduction of viscosity was observable, though due to the disturbances caused by the boiling O_2 the experimental accuracy was somewhat reduced. F. S. B.

1016. Viscosity of Homologous Esters. O. Albert. *Zeits. f. phys. Chem.* 182. *Abt.A.* 6. *pp.* 421–429, 1938.—The viscosities of a homologous series of esters has been measured at 20, 25, 100, and 180°C. The results show that the addition of a CH_2 increases the viscosity by a constant amount, and the correlation with molecular weight and temperature is discussed. The relation of Thorpe and Rogers is verified and the possibility of its application to substances of higher molecular weight is established.

F. J. L.

1017. Properties of Isomeric Octanes. A. Maman. *Comptes Rendus*, 207. *pp.* 1401–1402, *Dec.* 27, 1938.—The author has synthetically prepared the following octanes: Dimethylhexane, trimethylpentane (three different molecular structures) and tetramethylbutane. Certain essential physical and chemical data in respect of these five substances are given, including the temperature at which CO appears in the products of combustion. Some data on the variation of viscosity with temperature are also included. F. S. B.

1018. Viscosity of Normal Butanol. G. Jones and S. M. Christian. *Am. Chem. Soc., J.* 61. *pp.* 82–83, *Jan.*, 1939.—The density and viscosity of normal butanol have been determined at 0 and 25°. AUTHORS.

1019. Viscosity of Solutions of SO_2 in Organic Liquids. H. E. Adams and H. E. Rogers. *Am. Chem. Soc., J.* 61. *pp.* 112–115, *Jan.*, 1939.—Using a sealed, modified Ostwald viscometer, the viscosities of solutions of SO_2 in CCl_4, $CHCl_3$ and $CHBr_3$ at 25° were measured. Densities at 25°, and viscosity, fluidity and density curves for these solutions have been determined. Expansion in volume, on mixing, was found in each case. Evidence is furnished which shows that the fluidity is proportional to the free volume. AUTHORS.

1020. Viscosity of Pennsylvania Oils at High Pressure. R. M. Dibert, R. B. Dow and C. E. Fink. *J. of Applied Physics*, 10. *pp.* 113–115, *Feb.*, 1939.—Viscosity-pressure-temperature data are presented for six Pennsylvania oils which differ in chemical and physical properties at atmospheric pressure. This study is a continuation of one reported previously and employs the same apparatus and experimental method. While the pressure coefficient of viscosity increases in general with molecular weight, the relationship seems to be significant only for fractions of a narrow boiling range from a single oil. The mean temperature coefficient of viscosity, between 100° and 210° F., however, increases with molecular weight at all pressures for all the oil samples. [See also Abstract 2453 (1937).] AUTHORS.

1021. Influence of Temperature and Specific Volume on Viscosity of Liquids. Part II. W. R. van Wijk and W. A. Seeder. *Physica*, 6. *pp.* 129–136, *Feb.*, 1939. *In English.*—The volume in the closely packed state and the configurational heat of a number of liquids have been calculated from viscosity data at moderately elevated pressures. The configurational heat calculated in this way is the higher as the internal structure of the liquid is more pronounced. The same volume is found for a CH_2 group both in the straight chain primary alcohols and in the normal paraffins. It is shown that Hg behaves like a liquid without internal structure although it resembles the alcohols in that its viscosity is not mainly dependent on the density. This is, however, ascribed to the small thermal expansion of Hg as compared with organic liquids. [For Part I see Abstract 92 (1938).] AUTHORS.

1022. Relations between Viscosity and Elastic Properties of Amorphous Substances. W. Kuhn. *Zeits. f. phys. Chem.* 42. *Abt. B.* 1. *pp.* 1–38, 1939.—The Maxwellian relationship between rigidity modulus, relaxation time and viscosity is extended to substances in which several cohesive mechanisms of different relaxation times exist. The resultant viscosity equals a sum of partial viscosities. If an infinitely rapid deformation is produced the elastic modulus depends upon the time at which the stress is determined. The viscoelastic behaviour of materials differs according to the distribution of relaxation times. A small range of relaxation times corresponds to the behaviour of glycerin or glass. High molecular weight substances often possess a wide range of relaxation times and when a few are very long and the rest exceedingly short the substance shows high elasticity. The temperature variation of the elastic modulus of a material showing rubber-like elasticity over a narrow temperature range is described. If none of the relaxation times is infinitely large, flow occurs in addition to elastic reactions. In such cases, *e.g.*, polystyrol-glass, the

viscosity contribution of those mechanisms with small relaxation times may usually be neglected. J. B. W.

1023. Internal Friction in Solids. Part II. K. Bennewitz and H. Rötger. *Zeits. f. techn. Physik*, 19. 12. *pp.* 521–526, 1938.—Continuing an earlier paper [see Abstract 5030 (1936)] the authors give a general mathematical theory of thermal damping in torsional vibrations. On the basis of this theory the variation of the decrement (due to internal friction) with periodic time of the vibrating system is calculated and compared with experimentally obtained values in the case of German silver wires of various diameters. It is considered that the theoretical results are confirmed, and in particular it is concluded that the decrement depends on the dimensions of the specimen. K. M. C.

1024. Nature of Sliding and Analysis of Friction. F. P. Bowden and L. Leben. *Roy. Soc., Proc.* 169*A*. *pp.* 371–391, *Feb.* 7, 1939.—A detailed analysis of the kinetic friction between moving metals shows that the frictional force does not remain constant during sliding. Sliding is not a continuous process : the motion proceeds in jerks and large and violent fluctuations occur in the friction. In the case of dissimilar metals the top surface sticks to the bottom one and moves with it until, as a result of the gradually increasing pull, a sudden and very rapid slip occurs. The process is then repeated indefinitely. A simultaneous measurement of the surface temperature shows that this too is fluctuating and, at the instant of slip, there is a sudden temperature "flash." The exact behaviour depends upon the relative physical properties of the metals, particularly on the melting-point, and there is evidence that three distinct types of sliding may occur. The experiments suggest that friction is due to a welding together of the metals at the local points of contact. These metallic junctions are large compared with the dimensions of a molecule and when they are broken the metal is distorted to a considerable depth. Even if the surfaces are lubricated with mineral oils or other lubricants an intermittent clutching and breaking away of the surfaces occurs and the behaviour may be essentially the same. Certain long chain fatty acids may prevent stick-slip and allow continuous sliding to take place. [See following Abstract.]

AUTHORS.

1025. Area of Contact between Stationary and between Moving Surfaces. F. P. Bowden and D. Tabor. *Roy. Soc., Proc.* 169*A*. *pp.* 391–413, *Feb.* 7, 1939.—An estimate of the real area of contact between stationary and between moving metal surfaces has been made by electrical and by visual means. Experiments with stationary surfaces show that the area of intimate contact is very small. It varies with the pressure, but for flat steel surfaces it may be less than 0·0001 of the apparent area. The real area of contact is not greatly affected by the size, shape and degree of roughness of the surface ; it depends mainly on the pressure. The general behaviour is consistent with the view that the surfaces are held apart by small irregularities. This means that even with lightly loaded surfaces the local pressure may be sufficiently great to cause steel to flow plastically. This conclusion is supported by the observed relation between the pressure and the electrical conductance. The slope of such a curve indicates that, at the points of contact, plastic flow of the metal has occurred. Although the stresses may cause elastic deformation in the bulk of the metal, the experiments suggest that the irregularities on which the bodies are supported are crushed down until their cross-section is sufficient to enable them to support the applied load. Measurements made with moving surfaces

show that the area of contact is not constant but is fluctuating rapidly during sliding. A detailed analysis shows a remarkable correlation between these fluctuations and the frictional and temperature changes described in an earlier paper [see preceding Abstract]. It is clear that an intermittent clutching and breaking away of the surfaces is taking place and the results support the view that metallic junctions between the metals are being rapidly formed and broken. The nature of these junctions depends on the relative physical properties of the two metals and there is again evidence that three main types may occur. The conductance measurements show that even if the metals are lubricated with mineral oils and other lubricants, metallic contact may still occur through the film of lubricant. When the surfaces slide, fluctuations in the area of contact are observed and the behaviour may be essentially the same as for unlubricated surfaces. AUTHORS.

See also Abstracts 889, 892.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

See Abstract 1030.

COMETS AND METEORS.

1026. Observations of Comet Finsler (1937f). P. Rossier. *Arch. des Sciences*, 20. *pp.* 153–163, *July–Aug.*, 1938.

COSMOGONY.

1027. Fundamental Problems of Cosmogony and Newton's Law. G. Armellini. *Accad. Lincei, Atti*, 28. *pp.* 117–123, *Sept.*, 1938.—A further mathematical discussion is given [see Abstract 158 (1939)]. In conclusion the following observation is made: admitting the existence of the cosmological term, the total moment of the quantity of motion of the planetary system remains constant with time—as with the ordinary Newton's law—considering always internal forces. It yet tends, so to say, to pass from the sun to the planets, and that may explain the fact that in the hodiernal planetary system whilst the mass resides for the greater part in the sun the moment of the quantity of motion resides for the greater part in the planets. J. J. S.

See also Abstract 1052.

LATITUDE AND LONGITUDE.

1028. Propagation of Radio Waves and their Influence on Determination of Longitude. R. Jouaust and N. Stoyko. *Bull. géodésique, No.* 57. *pp.* 23–28, *Jan.–Feb.–March*, 1938.—A general description is given of factors affecting the propagation of short waves. Account must be taken of reflection at the E and F layers, the diurnal and seasonal variation in their heights and the resulting variation in the time taken for the electric waves. Abnormal reflection also plays a part. A formula is given for the path of the wave. R. S. R.

NEBULÆ.

1029. Dark Nebula in Auriga. G. Hartwig. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 191–245, 1939.—The region of the Milky Way from R.A. $4^h\ 19^m$ to $4^h\ 50^m$, dec. $+\ 32°\cdot5$ to $+\ 39°$ has been studied in detail with a view to measuring the total and selective absorption due to the dark nebula in Auriga. Photographic magnitudes of 6182 stars in this field and an unobscured neighbouring comparison field were obtained with a 15 cm. u.v. triplet working at $f/10$, using a blue filter and ordinary plates (effective wave-length about 4160 Å). Photovisual magnitudes of 2329 stars in both fields were obtained with a 17 cm. photovisual triplet working at $f/7$, using a yellow filter and panchromatic plates (effective wave-length about 5800 Å). Wolf curves, derived from star-counts down to various limiting magnitudes in the nebula and in the comparison field (reduced to the same galactic latitude), show that in the darkest regions the photographic absorption is 1·4 mag. for a mean distance of 100 to 200 parsecs, and 2·1 mag. at 350 psc. The results are verified by v.d. Pahlen's probability method. A discussion of the colour indices ($\lambda\lambda$ 4160–5800) shows that, when corrected for a zero-point error corresponding to a reddening of the polar sequence by 0·15 mag. (0·08 mag. on the international scale), the values for stars at 350 psc. in the most obscured regions show a reddening of 0·9 mag. The results are compared with those of Schalén, and the interpretation of Wolf curves is discussed in general terms. A. Hu.

See also Abstracts 1039, 1052.

PLANETS.

See Abstract 1052.

STARS.

***1030. Stellar Parallax Observations. S. Asklöf.** *Stockholms Observat. Ann.* 13. 2. [7 *pp.*], 1938. *In English.*—Since Jan., 1932, there have been about 300 clear nights during observing months at Stockholm (Aug.–May). The author describes the instrument and its adjustments, the observations (made only between 0 and 12 hr.) and the device for the orientation proposed by the author and designed by Lindblad, with the addition of a fine motion in position angle, which saves time in orienting the plates. He gives tables of the reduction of the plates and of the parallaxes of 20 stars. A. S. D. M.

1031. Kepler Motions and Theory of Annual Aberration of Light. G. Silva. *Accad. Lincei, Atti*, 28. *pp.* 124–131, *Sept.*, 1938.—In the ordinary astronomical theory of the aberration of light it is usual to attribute to the sun uniform rectilinear motion instead of motion with respect to the centre of mass of the solar system. In this paper the corrections required when this latter motion is taken into account are discussed. Reference is made to corrections of the second order which are due to perturbations in the orbital motion of the earth round the sun, and also to those due to the eccentricity of the terrestrial orbit. J. J. S.

1032. Constants of Velocity Ellipsoid from Radial Speeds. W. M. Smart. *Roy. Astron. Soc., M.N.* 99. *pp.* 61–70, *Dec.*, 1938.—The paper deals with the statistical application of a new method, based on radial speeds, for determining the values of the semi-major and semi-minor axes, $1/K$ and $1/H$, of the velocity ellipsoid (with two equal axes) and the longitude, G_0, of the vertex. Solutions have been obtained for

each of the spectral types B, A, F, G and K, all types from A to M and all types from B to M in each of three galactic zones. For types A to M and B to M the mean value of K/H for stars in all three zones is 0·70 in each instance, and the respective values of G_0 are 339°·5 and 335°·6. [See Abstract 3588 (1938).] AUTHOR.

1033. Determination of Colour Indices with Reflectors. K. G. Malmquist. *Stockholms Observat. Ann.* 13. 1. [18 *pp.*], 1938. *In English.*—The author uses colour indices for space distribution, both in and out of the Milky Way. He examines the methods of Seares, Trumpler and Öhman, but uses a half-colour filter and grating. This method has been examined by plates of the Praesepe Cluster. The instrument used is the 102 cm. Grubb reflector, the plates being taken in the Newtonian focus; the half-filter is Krieger's, and consists of a K_2 (yellow) and a 35D (violet) gelatin filter. The plates are Agfa Chromo Isorapid, and were developed for 5 min. in hydroquinone developer. Tables are given of the plate material, the colour computations, the distance corrections to m, and of their distribution, the colour indices of some polar sequence stars, and a catalogue of the colour indices of 223 stars in the Praesepe Cluster. There are diagrams of colour magnitudes in the Cluster, and of a graphical comparison between c_M and c_G. A. S. D. M.

1034. Spectrophotometric Investigations of Reddened Stars. W. Strohmeier. *Zeits. f. Astrophysik*, 17. 1–2. *pp.* 83–128, 1939.—The investigation covers 22 bright stars of all classes and 12 fainter B-stars. Spectra were taken during 1936 and 1937 with a 30 mirror prism camera. Two systems of reducing the spectrograms to give monochromatic brightness differences are employed. The observed differences are represented by mean long- and short-wave gradients. A general relation is set up between spectral type and relative gradient for giants in the blue and red by making use of previously determined gradient systems; the gradient excesses of the observed stars are then deduced. Reddening is observed only for earlier and later spectral classes, not for the middle classes; for B and cB stars the cause is selective absorption of interstellar matter, for cG and cK stars it is a radiation force effect. For all early-type stars the observed reddened spectral energy distribution can be represented approximately by one gradient in the region 635 to 400 mμ. The reddening of cB and B stars depends on the distance, this dependence is the same for regions of normal star density as for sparsely occupied regions; the spread of values about the mean reddening/distance curve is greatest in the regions least affected by interstellar matter. The differences between long- and short-wave gradients are positive for reddened B stars and increase with increasing reddening. The biggest positive gradient indices occur in the vicinity of the Milky Way. It is possible to explain the energy distributions in the spectra of the observed reddened B-stars by Mie's theory of absorption and scattering by Fe particles. J. E. K.

1035. Spectrophotometric Investigations of δ Cephei Stars. Part VI. η Aquilæ. Part VII. T Vulpeculæ. W. Becker and W. Strohmeier. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 137–147 *and* 182–190, 1939.—Relative gradients between η Aquilæ and δ Aquilæ and between T Vulpeculæ and HD204485 (F0) are derived in long- and short-wave spectral regions; the amplitudes of the long-wave gradient for η Aquilæ is 0·80 and of the short-wave gradient 0·95, corresponding amplitudes for T Vulpeculæ are 0·48 and 0·76. Amplitudes of monochromatic light curves at 557μ, 480μ and 410μ are $0^m{\cdot}64$, $0^m{\cdot}90$ and $1^m{\cdot}27$ for

η Aquilæ and $0^m \cdot 68$, $0^m \cdot 83$, $1^m \cdot 13$ for T Vulpeculæ. Amplitudes of colour indices are respectively $0^m \cdot 63$ and $0^m \cdot 45$ which when reduced to absence of absorption become $0^m \cdot 55$ and $0^m \cdot 34$. For η Aquilæ the maximum for gradients, light, colour index and spectral type curves occurs at $0^d \cdot 00$; the minimum, apart from the 3 light curves, occurs at phase $4^d \cdot 75$, for the 3 light curves the minimum occurs $0^d \cdot 25$ later. In the case of T Vulpeculæ the maxima and minima of gradients, light and colour index curves occur at phases $0^d \cdot 00$ and $3^d \cdot 05$ respectively; the spectral type curve is displaced in phase, the earliest type is $0^d \cdot 08$ in advance and the latest type $0^d \cdot 50$ in advance. The connections between brightness, gradient and spectral type for both increasing and decreasing branches of the curve are determined. [For Part V see Abstract 3589 (1938).] J. E. K.

1036. Distribution of Spectral Classes in Selected Areas of Southern Sky. F. Becker. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 148–169, 1939.—Statistics are given of the distribution in numbers of stars of the selected areas of the Southern Sky among the 11 spectral semi-classes of 6 main classes B, A, F, G, K and M. The nature of the dependence of distribution on apparent brightness, galactic breadth and length can be ascribed to three main effects, namely, the increase in abundance of stars from Class B to Class M, the gradual decrease of spatial star density at large distances and the flattened shape of the star system. The distribution of stars of all classes in the large concentration at 260° galactic longitude in the Southern Milky Way is the same as the overall average distribution. In the Scorpius-Sagittarius region of low star density the nearer stars (group G) predominate over the more distant ones (group A). Where fluctuations of distribution occur A- and G-stars show opposite trends in relative abundance. J. E. K.

1037. Rotation of a Fluid Star Stratified in Ellipsoidal Layers. P. Dive. *Comptes Rendus*, 207. *pp.* 1380–1384, *Dec.* 27, 1938.—The fluid of the star is non-homogeneous but it is assumed that the surfaces of equal pressure coincide with those of equal density. If the star is stratified in ellipsoids, it is proved that a second-order solution of the equations governing the rotation is possible. The properties of the ellipsoidal layers are also discussed. G. C. McV.

1038. Lane-Emden Function $\theta_{3 \cdot 25}$. S. Chandrasekhar. *Astrophys. J.* 89. *pp.* 116–118, *Jan.*, 1939.—A table gives the function $\theta_{3 \cdot 25}$ and certain other auxiliary functions of importance in the theory of stellar structure. A. Hu.

1039. Study of Galactic Rotation, Based on Velocities of Planetary Nebulæ. G. L. Camm. *Roy. Astron. Soc., M.N.* 99. *pp.* 71–90, *Dec.*, 1938.—The radial velocities of the planetary nebulæ have been analysed in an unusual way, in order to determine how the angular speed of rotation of the galaxy varies with galactic radius. As the treatment required a knowledge of the distances of the nebulæ, these have been estimated by a rather crude, but consistent, method, in which apparent magnitudes and angular diameters are treated as being equally reliable indicators of distance. The analysis of the radial velocities yielded values for the constants of solar motion, the distance and direction of the galactic centre, and the K-term. The variation of the angular speed of galactic rotation with distance is shown graphically. The proper-motions have also been examined, and it is shown how they can be used to determine the linear speed of rotation at the sun's distance. In this case the proper-motions are too few to make an accurate estimate. The linear speed at

the sun's distance is assumed, and the variation of the gravitational attraction of the galaxy is deduced. This variation is very similar to that arising from a thin circular disc, the density of which decreases uniformly outwards, together with massive nucleus at the centre. The best agreement between this model and the observed radial velocities of the planetaries is obtained when a mass of $0{\cdot}76 \times 10^{11}$ ⊙ is assigned to the nucleus, and a mass of $1{\cdot}01 \times 10^{11}$ ⊙ is assigned to the disc; these give a total galactic mass of $1{\cdot}77 \times 10^{11}$ ⊙. The whole investigation has only been possible because the exact expression for the relative radial velocity due to galactic rotation has been used throughout. Over so great an area of the galactic plane, approximate expressions would be inadequate.

AUTHOR.

1040. General Aspect of the Milky Way. E. A. Kreiken. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 170–181, 1939. *In English.*—On the assumption that dark cosmic clouds are distributed at random in continuous layers of stars in such a way that their mean space density is constant a distribution of obscured areas is computed which is much the same as that observed. From the occurrence of a few dark clouds in intermediate latitudes it is inferred that the cloud concentration must be very high in the direction of the galactic centre and gives rise to the very complex surface structure of the Milky Way. The probability of occurrence of "galactic windows" in the direction of the galactic centre is small; in the direction of the anticentre the numbers of nebulæ are small and external galaxies can be frequently observed. J. E. K.

1041. Effect of Radiation Pressure and Gravitation on the Distribution of Interstellar Matter. C. Schalén. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 260–284, 1939.—The author calculates the pressure D of radiation of given composition on absorbing particles of interstellar matter with diameters between 10^{-4} and 10^{-6} cm. The values are compared with those for totally reflecting particles in temperature radiation from 18,000 to 3,000° K. Similar calculations of the gravitational force S at the surface of stars of various spectral classes allow the quantities D–S and D/S to be derived. For the particle sizes considered, $D-S > 0$ in general, and a minimum distance of approach can be calculated for particles of known initial velocity. This distance is of the order of 1 to 10 psc. for B-stars, but is 100 times smaller for A0 stars. Early-type stars have thus a great influence on the distribution of interstellar matter by repelling small particles to great distances. Comparison with the observed stellar distribution in the neighbourhood of several dark clouds appears to show that the origin and form of the clouds may in fact be ascribed to such combined action of gravitational and radiation pressures from the hottest stars. A. Hu.

1042. Interstellar Absorption in Selected Regions of the Milky Way. Part I. W. Becker. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 285–315, 1939.—The researches on open star-clusters have shown that there cannot be a general distribution of interstellar absorbing material. The problem is now approached by a study of the dependence of colour-excess on distance for stars in different parts of the Milky Way. Spectral type is taken as the guide to absolute magnitude and hence to distance. Colour-indices for the different spectral classes are also given. It is then possible, using the author's new observations of colour-indices for stars in regions lying in ten Selected Areas within the Milky Way, to calculate colour-excess. It turns out that only in one region is a steady change of colour with distance

found. In the other regions the change of colour is of the kind which would be produced by irregular clouds of darkening material. In many directions the obscuration begins at 100 to 200 parsecs from the sun, but in others not until 1000 parsecs. G. C. McV.

1043. Emission and Absorption Lines in Interstellar Space. O. Struve. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 316–319, 1939.—It has been found in many parts of the Milky Way that Hα and OII3727 appear as emission-lines, although the associated gaseous nebulæ do not happen to be connected with O or B type stars. These lines are attributed to interstellar matter, which, however, does not show the Ca II and Na I lines except in absorption. A theoretical reason for this difference in behaviour is given. G. C. McV.

1044. Star Cluster in Coma Berenices. R. J. Trumpler. *Lick Observat., Bull. No.* 494. *pp.* 167–195, 1938.—The author furnishes a reliable list of the physical members of this group. It is a physical system with common motion of its stars, its position is $\alpha = 12^h{\cdot}18^m{\cdot}0$, $\delta = 26{\cdot}5(1900)$; distance, 75 parsecs; annual proper motion; $\mu_\alpha \cos\delta = -0''{\cdot}013$, $\mu_\delta = -0''{\cdot}017$, or $\mu = 0''{\cdot}021$ in position angle 218°; radial velocity $= -0{\cdot}4$ km./sec.; space motion relative to sun: 7·5 km./sec. toward $\alpha = 8^h4^m$, $\delta = -47°$; limiting diameter is 8°; linear diameter is 10 parsecs. The majority of the stars are (A_0 to K_0) dwarfs, a few A-F giants; total mass about 70 ⊙; average mass density is near the limit of instability. A. S. D. M.

1045. Photographic Observations of New Variables and Some Known Variables in Cygnus. K. Suzuki, M. Huruhata and G. Kuroiwa. *Imp. Acad. Tokyo, Proc.* 14. *pp.* 373–376, *Dec.*, 1938. *In English.*

1046. Spectroscopic Orbital Elements of α Aurigæ. W. Struve. *Zeits. f. Astrophysik*, 17. 1–2. *pp.* 61–82, 1939.—A new series of spectroscopic observations of α Aurigæ gives results in general agreement with those measured by Goos in 1908. Improved radial velocity data are obtained and on account of the greater number of measurements of component B a more reliable mass ratio, 1·2, is given. Certain inexplicable differences between the spectra of components A and B give rise to some doubt as to whether it can, as hitherto, be assumed that component B is of the same spectral type as A. J. E. K.

1047. Nova T Cor B in July, 1938. O. Hachenberg and P. Wellmann. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 246–259, 1939.—A second outbreak of this old nova occurred in the summer of 1938, when its brightness rose from the fairly steady value of 11·3 mag. to 10·0 mag. Simultaneous changes in the spectrum are described. The energy distribution in the continuous spectrum, which had, after the initial outburst, settled down to that of an early M-star (3000° K.), changed markedly with the rise in brightness and became better represented by a colour temperature of 6000° K. The emission lines, which had occasionally vanished in the period 1866–1936, reappeared strongly, though the lines N_1 and N_2 are still missing. The excitation temperature, derived from the intensity distribution in the emission lines, is 13,000° K. The amplitude of the light-curve, taken in conjunction with the alteration in gradient and the high excitation in the atmosphere, suggests that the system consists of a normal M giant accompanied by a very hot variable star, the nova proper. A. Hu.

1048. Apsidal Motion in Close Binary Systems. K. Walter. *Zeits. f. Astrophysik*, 17. 3–5. *pp.* 320–343, 1939.—The formulæ of Russell and of Walter for the apsidal motion for close binaries are compared and the differences between their basic physical assumptions are explained. It appears that the complete expression for the apsidal motion contains two terms, one of which depends on the distorted potential, the other on the degree of coupling between the period of rotation of a component in its orbit and about its axis respectively. The first term gives a forward motion to the apsidal line, the second, a retrograde. The calculations are carried out under the hypotheses that the internal rotations of the stars are not uniform and that the stars are not rigid. G. C. McV.

1049. New Eclipsing Variable of Large Mass. S. Gaposchkin. *Astrophys. J.* 89. *pp.* 125–129, *Jan.*, 1939.—More than a thousand photographic observations of the new eclipsing variable HD 163181 = HV 7868 = Boss 4520 have been secured from Harvard plates. The light-curve shows slight indications of ellipticity ; the minima are well defined, and both are of greater depth than $0^m.4$, so that the photometric relative elements may be regarded as of considerable precision. The velocity-curve published in 1928 by Humason and Nicholson refers to the star that is in front during the primary minimum ; it is slightly the larger, slightly the brighter, and slightly the more massive of the two components. There is an indication of a slow apsidal motion. A photovisual light-curve based on 87 observations confirms the variability and the range. The star is much redder than would be expected from its spectrum (Harvard, Oe ; Mount Wilson, B1e ; Lick, B0) ; the mean colour excess is $+ 0^m.57$. The principal results obtained are as follows : $P = 12^d.0042$; $i = 88°.4$; $k_{2,1} = 0{\cdot}917$; $r_1 = 5{\cdot}71$ ○ ; $r_2 = 5{\cdot}23$ ⊙ ; $\mu_1 = 44{\cdot}38$ ○ ; $\mu_2 = 40{\cdot}82$ ○ ; $\rho_1 = 0{\cdot}23$ ⊙ ; $\rho_2 = 0{\cdot}28$ ○ ; $L_1 = 0{\cdot}54$; $\gamma = 1{\cdot}03$; $b/a = 0{\cdot}985$. The star is unique in that its mass is of the same order as that of AO Cassiopeiæ or UW Canis Majoris, but the radii are much smaller, being similar to those of the components of Y Cygni. The spectra of all four stars are practically the same. The mass of the heavier component of HD 163,181 is about equal to that of the red supergiant component of VV Cephei (44·5 ⊙), but the radius is 420 times smaller than the radius of that star. AUTHOR.

See also Abstracts 1030, 1052, 1053, 1055, 1073.

SUN.

1050. Apparent Motions of Solar Prominences. W. H. McCrea. *Observatory*, 62. *pp.* 16–21, *Jan.*, 1939.—Curtis and Newton both find a great preponderance of downward velocities in prominences and flocculi, not to be explained by a Doppler shift of the image off the slit, nor by apparent motion seen transversely. Mostly the matter must become luminous, only, when at a certain height, as it cannot be coming from outside the sun. It may be illuminated by radiation from a distant locality, so that it must be high enough to " catch the light," and the prominences are seen in reflected light, in a manner similar to the common cloud. The radiation must be in all directions. The author illustrates this from the radio fade-outs which occur simultaneously with the outburst of a prominence near the brightened locality. But this again should leave the prominence dark at the same elevation when falling as it was made bright when ascending, and the problem remains still unsolved. A. S. D. M.

1051. New Zealand Total Solar Eclipse Expedition to Canton Island, 1937 June 8. C. B. Michie. *Roy. Astron. Soc., M.N.* 99. *pp.* 132–135, *Dec.*, 1938.

1052. Recent Progress in Astronomy. A. C. D. Crommelin. *Phys. Soc., Reports*, 5. *pp.* 82–99, 1938.

1053. Astronomical Spectroscopy. A. Hunter. *Phys. Soc., Reports*, 5. *pp.* 241–249, 1938.

1054. New Measures of Wave-Lengths of Ca Lines K and H. J. Evershed. *Roy. Astron. Soc., M.N.* 99. *pp.* 120–126, *Dec.*, 1938.—High dispersion spectra in the H and K region obtained with the liquid prism spectrograph, and others of less dispersion obtained with glass prisms, have been measured with a newly designed micrometer for the accurate determination of the wave-lengths of the Ca and other lines in the open arc, and for comparison with interferometer measures of H and K. A description is given of the micrometer and of the method of measurement. The computation of wave-lengths was made by the Cornu-Hartmann interpolation formula for many of the measures and compared with a simpler graphical method. Tables are given showing the results for Ca, Al and some of the Fe lines. The wave-lengths of the Ca lines are in very close agreement with those previously published by the author [see Abstract 1783 (1930)], but differ appreciably from the interferometer measures by the late C. V. Jackson. Possible causes of this difference are mentioned. The adopted wave-lengths of K and H reduced to zero pressure are compared with the values given in the Revision of Rowland's Table for the sun, showing a shift to red of these lines at the centre of the sun which is three times the Einstein effect. AUTHOR.

1055. Strength of Continua at Series Limits in Solar Spectrum. A. Unsöld. *Zeits. f. Astrophysik*, 17. 1–2. *pp.* 1–14, 1939.—Since, at the limit of a spectral series, the transition probability remains constant in terms of frequency, the relative intensity discontinuity at the head of the corresponding absorption continuum can be calculated from the observed equivalent breadths of the series lines. In the solar spectrum the author obtains for the Na 3^2P°-head at λ 4083 a discontinuity of only 0·04% ; whilst the strongest Mg head at λ 3755 is 0·76%. These values are discussed in conjunction with the observed fact that the Balmer discontinuity is of the order of 7%. It is shown that the absence of absorption beyond the Balmer limit in the spectra of white dwarfs can be explained if their temperatures correspond to those of normal B-stars, notwithstanding the A-type characteristics shown by their lines. A. HU.

See also Abstracts 1031, 1064, 1069, 1204.

GEOPHYSICS.

HYDROSPHERE, PHYSICS OF THE.

1056. Hydraulic Régime of Marine Basins. G. Evangelisti. *Ricerche di Ingegneria*, 6. *pp.* 188–191, *Nov.-Dec.*, 1938.—The problems of motions in semi-enclosed marine basins are treated from fundamental physical principles with a resulting simplicity. W. A. R.

LAND, PHYSICS OF THE.

1057. Effect of Viscosity on the Gravitational Stability of the Earth at its Liquid Cooling Stage. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 16. *pp.* 691–700, *Nov.*, 1938. *In English.*—A two-dimensional problem of the earth's crust is taken without regard to the surface curvature. Two cases of stability are discussed (1) for a plane boundary between two liquids extending upward and downward to infinity, and (2) a superficial layer of liquid resting on another which extends downwards to infinity. The criterion of stability is stated. It is found that viscosity affects gravitational stability to a small extent. Instability without viscosity would be changed to stability were the liquid viscous. For the stability to be realised the whole of the liquid need not be viscous and only a part near the boundary under consideration need be so. The results are applied to changes which occurred at the earth's surface when cooling in the liquid stage and with the present features of equilibrium in the earth's crust. The origin of earthquakes may thus be examined. [See Abstract 4027 (1938).] R. S. R.

1058. Earth's Temperature Arising from Radioactivity. A. N. Lowan and F. King. *Phys. Rev.* 54. *pp.* 1109–1110, *Dec.* 15, 1938.—Reference is made to an expression obtained earlier [see Abstract 5230 (1933)] for the contribution to the earth's temperature arising from radioactivity which can be written $T(r, t) = T_1(r) - T_2(r, t)$. The term $T_1(r)$ represents the distribution of temperatures corresponding to the steady state. An expression for $T_1(r)$ is obtained in closed form which can be computed as accurately as desired. In an expression for $T_2(r, t)$, a term whose order of magnitude is $e^{-R\alpha}$ is neglected. A table is constructed to obtain the maximum error in $T(r, t)$ for various depths (in miles) and when truncating the series after various numbers of terms. The error increases with depth. For 25 terms the residual error is below 1° C. up to a depth of 1500 miles. R. S. R.

1059. Temperature Attained in a Burning Coal Seam. L. F. Brady and J. W. Greig. *Am. J. Sci.* 37. *pp.* 116–119, *Feb.*, 1939.—A brief description is given of the occurrence of a traplike " rock " formed by the melting of shale by a burning coal seam, and of an experimental determination of the temperature range in which this material melts.

AUTHORS.

1060. Movement of Sand by Wind. D. Carroll. *Geolog. Mag.* 76. *pp.* 6–23, *Jan.*, 1939.—Dampness of the sand surface curtails the movement of sand grains by the wind, and therefore a climatic factor is operative. The difference between the wind required to move grains of damp and dry sand is a measure of cohesion. A strong gust of wind is often necessary to start grains moving. A change in the direction of the wind causes more movement than a long-continued wind from the same direction. After rain a slight consolidation of the surface by salt and calcium carbonate may prevent movement. W. A. R.

1061. Piezometric Surface of a Water-Bearing Layer Supplying any Number of Artesian Wells. R. Humery. *Comptes Rendus*, 208. *pp.* 213–215, *Jan.* 16, 1939.—Reference is made to an expression obtained with the help of Dupuit's Law relating the meridian of the piezometric surface, the radius of the outcrop of the layer, the hydrostatic load and the radius of the pipe. To extend this to the case of any number of wells an expression in the form of a determinant is obtained which

eliminates the unknown coefficients of permeability and gives the piezometric surface of an artesian field at any point. The expression agrees well with practical tests. R. S. R.

METEOROLOGY.

1062. Use of Vertical Sections in Studying Isentropic Flow. C. H. Pierce. *Monthly Weather Rev.* 66. *pp.* 263–267, *Sept.*, 1938.—As the isentropic chart gives only a thin sheet of the free atmosphere vertical cross-sections showing the arrangements of the isentropic surfaces prove very useful. The quantities represented are potential temperature and isentropic condensation temperature. Supplementary data such as temperature and relative humidity are also given. In an adiabatic process isentropic condensation temperature is invariant. An example of how the method can be used is given with illustrations. The value of the cross-section is seen in that it indicates the slope of not one but many isentropic surfaces and also aids in determining the stability of the atmosphere. The relation of fronts and isentropic surfaces is next considered. As fronts follow isentropic surfaces, the position and slope of the fronts which cut the cross-section plane can be identified. Though no actual cross-section has hitherto been got through a clear cut occluded front, diagrams are given which in the author's opinion represent what is likely to constitute the history of cold- and warm-type occlusions. A. E. M. G.

1063. Lapse Rate of Temperature in Lowest 100 m. of Atmosphere. N. K. Johnson and G. S. P. Heywood. *Meteorolog. Office, Geophys. Mem. No.* 77. [50 *pp.*], 1938.—The results of observations made during the 5-yr. period 1926–30 at Leafield (51°50½′ N., 1°34½′ W.) are analysed and discussed. The memoir is divided into three parts. In the first a description is given of the methods and instruments used in observing the various meteorological elements, particularly the temperatures, at definite heights above ground level. The second portion is devoted to an analysis of the records. The numerical results of the observations are given in tabular form, several of the results being also set out graphically. In the third section after comparing the values found in the present investigation with similar values obtained previously at Porton, the authors proceed to discuss atmospheric turbulence, its calculation from the temperature curves and the effect of wind velocity upon it. Other points dealt with are the rate of growth of nocturnal inversions and radiation temperature structure. A description of the life history of a typical radiation fog shows the sequence of events and the physical processes which led up to its formation and ultimate dispersion. All points are illustrated by graphs and tables. A. E. M. G.

1064. Variation of Solar U.V. Radiation during the Sunspot Cycle. E. V. Appleton and R. Naismith. *Phil. Mag.* 27. *pp.* 144–148, *Feb.*, 1939.—Measurements of upper-atmospheric ionisation by the critical frequency method show that the solar ionising agent (u.v. light) responsible for the formation of regions E and F_1 of the ionosphere varies by 120 to 150% during the sunspot cycle. The ionisation and electrical conductivities of these regions vary correspondingly by 50 to 60%. Authors.

1065. Computing Winds Aloft from Pressure and Temperature Fields. E. M. Vernon and E. V. Ashburn. *Monthly Weather Rev.* 66. *pp.* 267–274, *Sept.*, 1938.—As it is often impossible through the presence of low cloud to obtain exact information about winds aloft by pilot balloon

observation the method developed in this paper enables approximate values to be found. The direction and velocity of the wind at a particular level are calculated from the known pressure distribution at a lower level and the distribution of the mean virtual temperature of the air between the two levels. Equations are given enabling the two component vectors, the "isobaric" and the "thermal" to be calculated. These can be added vectorially giving the resultant wind. Scales for measuring the components have been constructed and are reproduced. The method of employment of the scales is explained and is illustrated by a particular example. Attention is drawn to the care which must be exercised in drawing the isotherms and isobars and also in dealing with the various sources of error likely to arise in estimating the results. Further, it is clearly pointed out that this is not a method of forecasting wind values. A. E. M. G.

1066. Law of Wind Structure near the Ground. H. U. Sverdrup. *Roy. Meteorolog. Soc., J.* 65. *pp.* 57–60, *Jan.*, 1939.—This note continues a discussion between O. G. Sutton and the author on the validity of the logarithmic law of wind structure near the ground. Sutton [see Abstract 1120 (1937)] showed that under stable, adiabatic, and unstable conditions, wind structure can be represented by a logarithmic function. The author considers that the law is valid under adiabatic conditions only but under stable and unstable conditions must be modified. In the present note he endeavours to show that the data which led Sutton to his conclusions can be interpreted differently. The treatment is based on the assumption that the total turbulent energy is the same under adiabatic and stable conditions if the rate of shear is the same. Comparison curves are drawn between observed relative wind velocities and velocities computed by (*a*) Sutton, (*b*) the author. Both methods apparently lead to satisfactory representation of observed conditions but the author considers that at greater distances from the boundary surfaces the wind profile is represented better by a power factor than by a logarithmic law. A. E. M. G.

1067. Diffusion and Fall of Atmospheric Condensation Nuclei. J. J. Nolan and P. J. Nolan. *Roy. Irish Acad., Proc.* 45*A*. *pp.* 47–58, *Nov.*, 1938.—Recalculations of results obtained previously by Nolan and Guerrini [see Abstract 560 (1936)] give for the diffusion coefficient of nuclei the value $D = 12 \times 10^{-6}$ cm^2./sec., and for the velocity of fall $V_g = 15 \times 10^{-5}$ cm./sec., with some uncertainty as to the validity of the method used in deducing the latter value. The results given refer to nuclei held during the experiments in a water-sealed gasometer. Further experiments with an oil-sealed gasometer give $D = 20 \times 10^{-6}$ cm^2./sec. Calculations of size from the values of D give radius $= 3{\cdot}55 \times 10^{-6}$ cm. for the experiments with the water-sealed gasometer, and radius $= 2{\cdot}68 \times 10^{-6}$ cm. for the experiments with the oil-sealed gasometer. An *Appendix* by **P. G. Gormley** [*ibid. pp.* 59–63] gives a solution of the problem of diffusion from a stream flowing through a thin rectangular slit, in which the numerical coefficients involved have been accurately evaluated. AUTHORS.

1068. Snow-Cover in Great Britain. G. Manley. *Roy. Meteorolog. Soc., J.* 65. *pp.* 2–24; *Disc.*, 25–27, *Jan.*, 1939.—For this investigation the records of mornings with snow lying at 9 h. from upwards of 90 stations have been examined. Forty-three of these records extend over 20 years while the whole period dealt with extends from 1912 to 1937. As only 48 of the stations examined are at an altitude above 400 ft.

many lower level stations are included in order to determine the effect of various factors affecting observations of snow cover. A relationship between the mean temperature of the winter months and the average frequency of occurrence of snow lying has been derived and tested and the various factors influencing the duration of snow cover considered. As a result the author is able to show that over a large part of Britain the "observed frequencies" of snow lying at morning observation are close to the "expectations" to be deduced according to the relationship established. Numerical results are given in tabular form. The importance of the investigation, both from the practical point of view and as a starting point for future research, is stressed in the discussion which followed.

A. E. M. G.

1069. Cellular Vortices and Band Vortices. Applications to Astrophysics and Meteorology. H. Bénard and D. Avsec. *J. de Physique et le Radium*, 9. *pp.* 486–500, *Nov.*, 1938.—An account is given of recent work on thermo-convection vortices as applied to the study of cloud formations and the extension of the theory of cellular vortices to an interpretation of the granulations of the solar photosphere. N. M. B.

1070. Cloud Forms. G. T. Walker. *Roy. Meteorolog. Soc., J.* 65. *pp.* 28–30, *Jan.*, 1939.—The cloud types considered arise in connection with (1) transverse, (2) longitudinal cells which develop in an unstable layer of air when there is (1), slow, (2) rapid shear between the top and bottom boundary layers. The features of transverse clouds are first dealt with, and illustrated by diagrams and cloud photographs. Longitudinal and fan-shaped clouds are then treated in the same way. The author considers that further work is necessary and that until the forms have been reproduced in the laboratory there must be doubt as to the interpretation put upon them. A. E. M. G.

1071. Duration and Intensity of Twilight. H. H. Kimball. *Monthly Weather Rev.* 66. *pp.* 279–286, *Sept.*, 1938.—From a review of the literature it is found that astronomical twilight begins or ends when the true position of the sun's centre is 18° below the horizon. On the other hand it appears that civil twilight ends or begins when the true position of the sun is 6° below the horizon. The differences in tables giving the duration of twilight are shown to depend on the position of the sun defining sunrise or sunset. In the U.S.A. this is defined as the point when the upper limb of the sun coincides with the true horizon. The intensity of twilight illumination is examined and a comparison of that at sunrise, sunset and the end of civil twilight made with that from the zenithal full moon. The results of the photometric measurements for varying solar altitude are given graphically. A. E. M. G.

1072. Decrease of Blue and Red Light at the End of Twilight. R. Grandmontagne. *Comptes Rendus*, 207. *pp.* 1436–1438, *Dec.* 27, 1938.—With an improved form of photometer, whereby the time required for an observation is reduced from 10 min. to 30 sec., and the use of additional glasses, more accurate log (intensity)/(depression of sun) curves were obtained. The results indicate that until the sun is 10° below the horizon there is practically no variation in the relative intensities of its blue ($\lambda\lambda$ 3600–4600) and red ($\lambda\lambda$ 5800–9000) lights, both decreasing at the same rate, but below that the blue light continues to decrease till the sun is 13° below the horizon, while the red light remains approximately constant.

C. A. S.

1073. Atmospheric Extinction Coefficients at Breslau and Belkawe. S. Vocke. *Zeits. f. Astrophysik*, 17. 1–2. *pp.* 15–60, 1939.—The mean extinction coefficients of the atmosphere at the observatories of Breslau and Belkawe are determined from observations of 46 stars. The dependence of transmission coefficient on wave-length is estimated by using 3 colour filters of effective wave-lengths 512, 543 and 599 $m\mu$ respectively. The two methods used involve an east-west comparison of stars and an estimation of zenith magnitudes. The usefulness of an artificial comparison star for such work as this is pointed out. A by-product of the investigation is the definition, for the photometric apparatus used, of a scale of magnitudes for 30 stars at the above effective wave-lengths. The relations between atmospheric transparency and humidity, and between measured extinction coefficients and visual estimates of the transparency, are explored. The results are compared with those obtained at other observatories. A. Hu.

***1074. Improved Radio Meteorograph on the Olland Principle. L. F. Curtiss, A. V. Astin, L. L. Stockmann and B. W. Brown.** *Bureau of Standards, J. of Research*, 22. *pp.* 97–103, *Jan.*, 1939.—A description is given of the construction and tests of a radio telemeter of high precision built according to the Olland principle, in which all indicating arms rotate on a common axis. Combined with a 5-m. radio transmitter of push-pull type, this telemeter provides a radio meteorograph which has been tested under actual working conditions and found to be reliable and accurate in its indications. Since it gives relatively strong signals with a good stability in frequency, it is easy to operate and very little retuning during an observation is required. Special attention has been given to the thermal insulation of the compartment containing batteries and transmitter so that no failures due to drop in battery temperature have been observed even at altitudes above 60,000 ft. The cost of manufacture compares very favourably with that of other models recently developed. Authors.

1075. Meteorology. D. Brunt. *Phys. Soc., Reports*, 5. *pp.* 100–120, 1938.

1076. Geophysical Research in Polar Regions. C. S. Wright. *Journ. Sci. Instruments*, 16. *pp.* 44–46, *Feb.*, 1939.—Discourse given at the Physical Society's 29th Annual Exhibition, 1939.

See also Abstracts 948, 1177, 1203, 1250, 1367, 1368, 1410.

SEISMOLOGY.

1077. Estimation of Focal Depth from Macroseismic Data. H. Neuberger. *Seismological Soc. of America, Bull.* 28. *pp.* 259–261, *Oct.*, 1938.—A new formula for estimating focal depth is obtained. W. A. R.

1078. Anomalous Dispersion of Elastic Surface Waves. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 16. *pp.* 683–689, *Nov.*, 1938. *In English.*—The results obtained earlier [see Abstract 3627 (1938)] have been extended to ascertain the general features of the problem for widely different cases of the dispersion curves, the calculation being extended to the cases $\mu^1/\mu = 0{\cdot}8,\ 0{\cdot}58,\ 0{\cdot}50,\ 0{\cdot}44,\ 0{\cdot}40$ ($\lambda = \mu$, $\lambda^1 = \mu^1$), while ρ^1/ρ remains $0{\cdot}5$. The nature of the velocity equation obtained earlier in a simplified form is also rediscussed from a more analytical point of view. The amplitude distribution of the types of

waves is discussed. The type of dispersion curve for various forms of stratification is described. R. S. R.

1079. North Sea Earthquake of 1931, June 7. H. C. Versey. *Roy. Astron. Soc., M.N., Geophys. Supplement*, 4. *pp.* 416–423, *Jan.*, 1939.—The disturbed area extended from Norway to Le Mans, and from Waterford to Brunswick. This region of 400,000 sq. miles is larger than that shaken by any previous British earthquake. The epicentre was situated near the Dogger Bank. The macroseismic effects as recorded by nearly 400 observers are summarised. It is concluded that the earthquake was due to isostatic recovery, the release of strain being localised on the submarine continuation of one of the tectonic lines of N.E. Yorkshire. W. A. R.

***1080. Electromechanical Transducer in the New Benioff Seismograph. J. J. Devlin.** *Seismological Soc. of America, Bull.* 28. *pp.* 255–258, *Oct.*, 1938.—Criticism of the old form of the transducer [see Abstract 1146 (1936)] has led to the construction of another type consisting of a permanent magnet, two pole pieces and two armatures. The armatures are made of two iron cores, around which are wound coils separated from the pole pieces by air gaps. The two armatures are arranged symmetrically with respect to the pole pieces. The coils are connected in series aiding. The armatures with the coils are attached to the reactor of the seismograph, and the magnet to the frame. By this arrangement, with a variation in the position of the armatures, there is a change in the flux path, inducing a current which is transferred to the galvanometers by means of a resistance circuit. In practice two sets of coils are wound on the cores, one for a short-period and one for a long-period galvanometer. W. A. R.

***1081. Comparison of Electromagnetic Seismographs. G. Grenet and P. Quency.** *Comptes Rendus*, 208. *pp.* 218–219, *Jan.* 16, 1939.—Tests were made over periods of one and two months with a Wenner type and a long-period Benioff type of seismograph. The latter was found better for short period P waves and the former for S waves since with the Wenner type the P waves were less amplified. A new Wenner type was devised which amplifies the short waves but gives normal amplification for waves of teleseisms. R. S. R.

See also Abstracts 1057, 1306.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

1082. Atmospheric Conductivity and Ionisation in the Alps. J. Moussiegt. *Comptes Rendus*, 208. *pp.* 216–217, *Jan.* 16, 1939.—Measurements were made with an Israël ion counter at Petites Roches Plateau at a height of 1150 m. Values are given of the total number of positive and negative ions, the atmospheric conductivity, number of small ions, and the ionic mobilities. A complex diurnal variation of conductivity was obtained with a minimum near to midday. R. S. R.

1083. Electric Current System of Geomagnetic Disturbance. E. H. Vestine and S. Chapman. *Terr. Mag.* 43. *pp.* 351–382, *Dec.*, 1938.—The larger part of the daily variation-field is caused by sources external to the earth, whilst a certain smaller part (not more than 30% of the whole) is due to internal causes. In the present investigation the average features of geomagnetic disturbance are considered. Alternative theoretical forms of current-systems proposed by Birkeland (B) and

Chapman (C) are examined. System B flows within the atmosphere, with an intake and outflow of current from space near the zones of maximum auroral frequency. The polar part of system C flows entirely within the atmosphere upon an approximately spherical surface concentric with the earth. In addition there may be a part in the form of a ring-current encircling the earth at a distance of a few earth-radii. The results are discussed as to the extent to which they succeed in reproducing the force-components of average geomagnetic disturbance given by observation.

G. E. A.

1084. New Non-Magnetic Ship "Research." J. A. Edgell. *Terr. Mag.* 43. *pp.* 389–392, *Dec.*, 1938.—The building of the new non-magnetic ship for the British Admiralty was begun in Sept., 1937, and Commander Peters of the " Carnegie " is giving help as consultant. The auxiliary Diesel engines of 160 h.p. are made of a bronze alloy with a crank shaft of non-magnetic steel. Rigorous care is being taken in the matter of iron nails, tins, cutlery and other magnetisable material. The engines will develop a speed of 6½ knots with a range of 3,000 miles. The vessel has a length of 142½ ft. on the water line, breadth 34 ft., draught about 13 ft., and will be brigantine rigged. Accommodation is provided for 6 officers, 4 scientists, and 22 petty officers and men. There will be two magnetic observatories and two laboratories, and a list is given of the instruments for magnetic, atmospheric-electric, oceanographic and meteorological observations. It is expected that the vessel will be launched in Feb., 1939, and will be ready for her first voyage after Oct., 1939.

G. E. A.

1085. Summary of Year's Work, Department of Terrestrial Magnetism, Carnegie Institution of Washington. J. A. Fleming. *Terr. Mag.* 43. *pp.* 409–416, *Dec.*, 1938.—The year ended June 30, 1938, saw the completion of the Atomic Physics Observatory and progress in the installation of its electrical equipment. The generator and tube are designed to operate at potentials of over 5 million volts. Automatic multifrequency equipments for ionospheric measurements have been installed at Huancayo and Watheroo. Tests were made on blue mud taken from the N. Atlantic, in which changes in magnetic declination as great as 90° were measured. The material is regarded as representing sediments deposited over several thousand years. A world map of secular variation activity was constructed for the interval 1885–1922, showing isopors for the total change vector. The weekly magnetic character figures (C_A) for 7 American-operated observatories were compiled and published weekly. The Potsdam *Kennziffer* differs from C_A in the division of the Greenwich day into 8 3-hour intervals. The average characteristics of disturbance in the earth's magnetic field are in good agreement with the world-wide atmospheric-electric current system of magnetic storms proposed by Chapman. If these currents flow in closed circuits in the atmosphere, their height is deduced as roughly 100–150 km. World-wide decreases of 3 to 5% in daily means of cosmic-ray intensity were associated with changes in the earth's magnetic field during two major magnetic storms. Measurements of air conductivity, and the effect of Aitken nuclei at a height of 19–22 km. in reducing this are discussed. The lunar variation in earth currents is semi-diurnal in character and is about 1/6th that of the solar diurnal variation. Isolation of the radio fade-out in a particular region brought the result that ionisation in the outer atmosphere, produced by u.v. rays emanating from bright chromospheric eruptions, is

absorbed almost exclusively below the level of 90 km. It is argued from this that the electrical currents causing the diurnal variation in the earth's magnetism must flow below this level. The ionosphere is now under continuous observation at Huancayo and Watheroo. The Department's pioneer measurements of new nuclear forces have been amply confirmed. G. E. A.

1086. Construction of an Azimuthal Equidistant Map Centred about the Geomagnetic North Pole. M. J. Pollak. *Terr. Mag.* 43. *pp.* 473–475, *Dec.*, 1938.—The azimuthal equidistant projection is one in which all distances measured from the centre of projection, in this case the north geomagnetic pole, are proportional to the equivalent great circle distances on the globe and all plane angles at the centre of projection equal their corresponding spherical angles. A network of polar coordinates was drawn to supply the basic network on which the points of intersection of the geographic coordinates were plotted and to constitute the geomagnetic coordinate system of the map. The length of a degree of latitude was determined arbitrarily to fit the desired size of the map. To transform from geographic to polar coordinates an intermediate step to geomagnetic coordinates was used. Geographic and hydrographic features are added to the map after the geographic coordinates have been drawn. R. S. R.

See also Abstracts 1076, 1133, 1367, 1358, 1423.

RADIOACTIVITY.

1087. Calculation of Internal Conversion Coefficients. S. M. Dancoff and P. Morrison. *Phys. Rev.* 55. *pp.* 122–130, *Jan.* 15, 1939.—The internal conversion of nuclear γ-rays is treated by methods suited especially to the cases of the artificially radioactive elements. The paper is divided into five parts: Section 1 discusses the radiative transitions in nuclei of middle atomic weights, where large angular momentum changes and low energy of excitation may be expected; in Section 2 the selection rules for the various types of nuclear radiation, and the conditions on their strictness are considered; in Section 3 the choice of potentials for the representation of the multipole fields are examined; Section 4 contains calculations leading to a non-relativistic formula for the conversion of electric multipole radiation of any order, applicable for $Z < 40$ and γ-ray energy $\ll mc^2$; and very simple relativistic formulæ are derived, good for high γ-ray energy but restricted to low binding, $Z < 30$, for both magnetic and electric multipoles of any order. The qualitative behaviour of the formulæ are summarised in conclusion. AUTHORS.

1088. Element 87 Obtained from Ac. M. Perey. *Comptes Rendus*, 208. *pp.* 97–99, *Jan.* 9, 1939.—A β-ray active element has been obtained from Ac, previously separated from its radioactive derivatives. The new element separates chemically with Cs, and is assumed to be an isotope of element 87 produced from α-disintegration of Ac. Its half-life is 21 min., and the β-ray half-value thickness is 0·18 mm. Al. Lines corresponding to a stable isotope of element 87 have already been observed with an X-ray spectrograph [see Abstract 3722 (1936)]. E. E. W.

1089. Isotopic Constitution of Uranium and Half-Lives of Uranium Isotopes. A. O. Nier. *Phys. Rev.* 55. *pp.* 150–153, *Jan.* 15, 1939.—A mass-spectrographic determination of the relative abundances of U isotopes has been made. The following abundance ratios were found : $U^{238}/U^{235} = 139 \pm 1\%$; $U^{238}/U^{234} = 17{,}000 \pm 10\%$. A search was made for other isotopes but none was found. From the above values, together with the results of the α-particle counting experiments of Kovarik and Adams, and the assumption that the Ac series is 4·6% as active as the U, the following decay constants are computed : U_I, $1{\cdot}520 \times 10^{-10}$ yr.$^{-1}$; U_{II}, $2{\cdot}6 \times 10^{-6}$ yr.$^{-1}$; AcU, $9{\cdot}72 \times 10^{-10}$ yr.$^{-1}$. The corresponding half-lifes are, respectively, $4{\cdot}56 \times 10^9$ yr., $2{\cdot}7 \times 10^5$ yr. and $7{\cdot}13 \times 10^8$ yr. [See following Abstract.] AUTHOR.

1090. Isotopic Constitution of Radiogenic Leads and Measurement of Geological Time. A. O. Nier. *Phys. Rev.* 35. *pp.* 153–163, *Jan.* 15, 1939.—The isotopic constitution of 21 samples of radiogenic lead has been determined with a mass spectrometer and the results have been correlated with mineral analysis data available for the specimens from which the leads were extracted. The common lead contamination in the samples was found, on the whole, to agree closely with that estimated from earlier atomic weight determinations. The AcD/RaG ratios (Pb^{207}/Pb^{206} ratios corrected for common lead contamination) appear to be in better agreement with a value 4·6% for the present day ratio of the activity of the Ac series to that of the U series than with the directly determined and commonly accepted value 4·0%. The results indicate that AcU was not nearly as abundant in the early days of the earth as was at one time believed. The measurement of geologic age from AcD/RaG ratios is discussed and it is shown that in the event of mineral alteration the ages obtained are more reliable than those found from the Pb/U ratios. The relatively small amount of Pb^{204} present in samples containing a large amount of Th indicates that it is extremely unlikely that Pb^{208} decays to Pb^{204}. [See also Abstract 3438 (1938) and preceding Abstract.] AUTHOR.

1091. Determination of Small Amounts of Emanation in Water. J. Clay and F. Westerhof. *Physica*, 6. *pp.* 177–183, *Feb.*, 1939. *In English.*—The amount of emanation in water was measured by bringing 200 cm^3. into an ionisation chamber of 3 l. For tap-water the authors found $0{\cdot}91 \times 10^{-14} - 1{\cdot}4 \times 10^{-14}$ Curie/cm^3. with an accuracy of 5% for one sample. The amount in water of the Sörfjord near Bergen was found to be $2{\cdot}8 \times 10^{-14}$ Curie/cm^3. From this the correction of the ionisation measurements due to cosmic rays was computed to be 1·0%, on account of the radioactivity of the surrounding water. AUTHORS.

1092. Excitation Function of Artificial Radioactivity. L. S. Ornstein, J. M. W. Milatz, E. F. M. van der Held and W. Maas. *K. Akad. Amsterdam, Proc.* 41. 10. *pp.* 1049–1050, 1938. *In English.*—A sensitive method of measuring the artificial radioactivity of Al is described in which the Al walls of a Geiger-Müller counter are bombarded with α-particles. The time of decay was determined for various α-particle energies and found to be constant at 3·4 min. The activity, plotted as the number of kicks, against the α-particle energy, shows the existence of resonance levels which appear to have approximately the same probability of excitation. G. O. B.

1093. Radioactivity Induced in Mo by Deuterons. B. N. Cacciapuoti. *N. Cimento*, 15. *pp.* 425–426, *July*, 1938.—Continuing the work

on the radioactivity produced in Mo on bombardment with deuterons from the cyclotron at Berkeley, U.S.A., in addition to the β-activity, a γ-activity is found. It has a half-period of 62 *d.* and was half-absorbed in a thickness of 2·5 gm./cm^2. of Al. F. C. C.

1094. Neutron-Induced Radioactivity of Uranium. O. Hahn and F. Strassmann. *Naturwiss.* 27. *pp.* 11–15, *Jan.* 6, 1939.—In an earlier paper [see Abstract 208 (1939)] it was shown that the irradiation of U with neutrons produced several isotopic nuclei. In this paper an attempt is made to show that these isotopes are RaII, RaIII and RaIV by chemical separation from the mixture of isotopes and a determination of their half-value times. The times found for the three Ra isotopes are 14 ± 2 min., 86 ± 6 min. and $250 - 300$ hr. respectively. Further investigations however show that there are several indications that the Ra isotopes have the properties of the Ba group. Amongst other evidence that is produced is the fact that the mass numbers Ba + Ma = 138 + 101 = 239, which is the atomic weight of U. It is not certain whether facts such as this are purely fortuitous or not, but the question of the constitution of the active members does not appear to be settled. G. O. B.

1095. Nuclear Isomerism Produced by a Continuous Spectrum of X-Rays. B. Pontecorvo and A. Lazard. *Comptes Rendus*, 208. *pp.* 99–101, *Jan.* 9, 1939.—By irradiating In with X-rays having a continuous spectrum with maximum energy 1850 kV, a β-ray activity is obtained with half-life $3·9 \pm ·05$ hr. and half-value thickness 0·05 mm. Al. The active element is identified with metastable In^{115} previously obtained from In by bombardment with fast neutrons. The present method of preparation is an example of nuclear fluorescence produced by X-rays, and avoids the production of accompanying artificially-active elements giving β-rays. E. E. W.

1096. Artificial Radioactivity Produced by Protons. L. A. Delsasso, L. N. Ridenour, R. Sherr and M. G. White. *Phys. Rev.* 55. *pp.* 113–121, *Jan.* 15, 1939.—The artificial radioactivity produced in targets of Cu, Ni, Ag, Cr and Mo by bombardment with 4eMV protons has been studied. In Cu, the (p, n) reaction gives rise to the radio-elements Zn^{63} (half-life 38·5 min., upper limit of positron spectrum 1·8 eMV) and Zn^{65}. Two new radioactive isotopes of Cu are found in Ni bombarded with protons; they have tentatively been assigned as follows: Cu^{58}, half-life 81 sec., and Cu^{60}, half-life 7·9 min. Both emit positrons. Also produced in Ni are Cu^{61}, both by the (p, n) and the (p, γ) reaction (threshold $< 1·8$ eMV) and Cu^{64}, by the (p, n) reaction (threshold apparently 2·1 eMV). Proton bombardment of Ag results in a radioactive Cd isotope which emits very soft negative electrons which are believed to be conversion electrons of a nuclear γ-ray. The identification of the responsible Cd isotope and the mode of decay is discussed. The half-life of this radio-element is 6·7 hr.; the threshold for the reaction is 2·4 eMV. 40-min. Mn^{51} is formed by proton bombardment of Cr. This radioelement emits positrons. Three unassigned activities produced in Mo have half-lives of 45 min., 2·7 hr. and 36·5 hr.; the last emits negative electrons. AUTHORS.

1097. Angular Distribution of Disintegration Products of Light Elements. R. O. Haxby, J. S. Allen and J. H. Williams. *Phys. Rev.* 55. *pp.* 140–146, *Jan.* 15, 1939.—The angular distributions of the following reactions: $Li^6 + H^2 \rightarrow 2He^4$; $H^2 + H^2 \rightarrow H^3 + H^1$; $B^{11} + H^1 \rightarrow Be^8 + He^4$; $B^{11} + H^1 \rightarrow 3He^4$ have been investigated over the

range of angles from 45° to 150° and over a range of bombarding voltages between 100 and 200 kV. The Li reaction was found to be spherically symmetrical. The deuteron-deuteron protons were found to have an angular distribution in the centre of mass system of coordinates represented by $1 + 0{\cdot}7 \cos^2 \theta$ over a range of bombarding voltages from 106 to 190 kV, with no measurable dependence upon deuteron energy. The third reaction, a resonance process, investigated at 190 kV, gave an angular distribution represented by $1 + 0{\cdot}7 \cos^2 \theta$. The continuous energy distribution α-particles with ranges greater than 30 mm. from the fourth reaction show an angular distribution which is dependent on the proton energy and indicate an intimate connection between the alternate modes of disintegration. [See following Abstract.] AUTHORS.

1098. Disintegration of Boron by Protons. E. L. Hill and R. O. Haxby. *Phys. Rev.* 55. *pp.* 147–149, *Jan.* 15, 1939.—The measurements on the angular distribution of the α-particles arising from the bombardment of B by protons given in the preceding paper [see preceding Abstract] are discussed. It is suggested that the particles from the continuous distribution which show an angular distribution have a common origin with the particles in the homogeneous group at 44 mm., and that further, this latter group may not be a truly homogeneous group, but may arise from a peculiarity of the three-particle disintegration. AUTHORS.

1099. Independent Determination of Binding Energy of Deuteron. F. T. Rogers, Jr. and M. M. Rogers. *Phys. Rev.* 55. *pp.* 263–269, *Feb.* 1, 1939.—This paper is an account of an experiment designed to determine the binding energy of the deuteron by a method which is relatively insensitive to uncertainties in the energy-range relation for protons of low energy. The protons, produced by the disintegration of ThC″ γ-radiation, were observed in a low pressure cloud chamber in a strong magnetic field. The curvatures of the tracks allowed the calculation of the corresponding kinetic energies. The final value of the binding energy as given by this experiment is $\overline{V}_B = (2{\cdot}17 \pm 0{\cdot}05) \times 10^6$ eV, which is in reasonable agreement with previous determinations by others. The uncertainty 0·05 eMV is the *maximum* uncertainty to be expected in this value of the binding energy. AUTHORS.

1100. Passage of Ionising Particles through Photographic Emulsions. H. J. Taylor. *Science and Culture*, 4. *pp.* 379–382, *Jan.*, 1939.—Briefly describes some uses of the method of direct registration of tracks of ionising particles in photographic emulsions, considering both α-particles and protons. The uses dealt with are the photographic examination of the disintegration of B and Li incorporated in the emulsion, the recording of the five α-particles emitted when radiothorium breaks up, the investigation of very weak radioactive elements, and the study of cosmic radiation. R. C. F.

1101. Effect of Temperature on Ionisation Produced by α-Particles. W. Seitter. *Ann. d. Physik*, 34. 2. *pp.* 113–129, *Jan.*, 1939.—The effect of temperature and pressure on ionisation produced by α-particles in air, Ne and Kr was determined from the current-pressure curve for different potentials and over a temperature range of about 200° C. The temperature coefficient decreased with increasing gas pressure with Ne and Kr and became almost zero. Comparison with present theory does not give exact agreement. The recombination coefficient increases slowly with pressure at room-temperature and reaches a maximum. It

decreases with rising temperature in the observed pressure range, a fact which is simply explained in terms of density variation. F. C. C.

1102. Value of $G^2|M|^2$ in the Theory of β-Spectra. E. F. M. van der Held. *K. Akad. Amsterdam, Proc.* 41. 10. *pp.* 1094–1095, 1938.—It has previously been shown that the best experimental β-spectra which are available can be represented by a linear combination of the solutions given by Fermi and by Konopinski-Uhlenbeck. It is supposed that this holds for all nuclei, electron- and positron-emitters. A hundred values of Fermi's constant $G^2|M|^2$ have been calculated. It would be expected that the values of log $\{G^2|M|^2\}$ plotted against Z would lie about some Sargent curves. As a matter of fact they do tend to lie on curves, but such curves are not Sargent curves. Modifications and extensions of the present theory are suggested to account for this. A. W.

1103. Energies of Soft β-Rays of Rb and Other Bodies. Method for Their Determination. W. F. Libby and D. D. Lee. *Phys. Rev.* 55. *pp.* 245–251, *Feb.* 1, 1939.—A method for measuring the upper limits of soft β-spectra by use of screen wall tube counters filled with H_2 is described. Illustrative results are given for Rb^{87}, Na^{22}, S^{35}, and Au^{198}. AUTHORS.

1104. β-Rays of Mesothorium 1 and Radium D. D. D. Lee and W. F. Libby. *Phys. Rev.* 55. *pp.* 252–258, *Feb.* 1, 1939.—Mesothorium 1 has been prepared from an old sample of thorium sulphate whose purity was demonstrated by measuring the rate of decay of ThB prepared therefrom. The mesothorium 1 was shown to be free from contaminations of other Th decay products and isotopic radioactive elements by measuring the rate of growth of mesothorium 2, and proving the absence of α-emitters. Magnetic deflection and Al absorption experiments have shown that the particles emitted are electrons whose maximum energy is $53{,}000 \pm 4000$ eV. Samples of RaD and RaE, pure to within 0·3%, have been prepared. The momentum of the most energetic conversion β-ray of RaD has been determined as 765 ± 32 gauss cm., and the upper limit of the RaE continuous spectrum was found to be 5150 ± 250 gauss cm. The upper limit apparently to be assigned to the primary β-ray spectrum of RaD was determined as 546 ± 10 gauss cm., or $25{,}500 \pm 1000$ eV, in agreement with the determination of Richardson and Leigh-Smith. An estimate of the observed number of secondary β-rays arising from the conversion of the 47·2 ekV γ-rays of RaD indicates the emission of five to ten such electrons per 100 disintegrations, in rough agreement with the results of Kikuchi and the predictions of Fisk for the L conversion of dipole radiation, but in complete disagreement with the conclusions of Stahel and v. Droste. Reasons for this disagreement are given. AUTHORS.

1105. Absorption Coefficient of 5·8 eMV γ-Radiation in Al. J. Halpern and H. R. Crane. *Phys. Rev.* 55. *pp.* 258–259, *Feb.* 1, 1939.—The absorption coefficient of monochromatic 5·8-eMV radiation in Al is found to be $0{\cdot}075 \pm 0{\cdot}009$ cm^{-1}. By deducting the theoretical value of the pair absorption coefficient, the Klein-Nishina absorption coefficient is found, which is $0{\cdot}062 \pm 0{\cdot}009$ cm^{-1}. This value is in good agreement with the theoretical value. The experimental method used is such that all quanta which are scattered more than 10 degrees in the Al are excluded completely from the data. AUTHORS.

1106. Pair Internal Conversion Coefficient in the F + H′ Reaction and Measurements on the γ-Ray Spectrum. J. Halpern and H. R. Crane. *Phys. Rev.* 55. *pp.* 260–262, *Feb.* 1, 1939.—The

γ-radiation from F + H′ was studied by the cloud-chamber method and was found to consist of a single line at 5·8 eMV. The group of electrons at about 4 eMV found by Gaerttner and Crane was confirmed, and it is shown that this group probably consists of the negative members of internal conversion pairs. The coefficient for pair internal conversion was measured and found to be about 1 pair per 100γ ray quanta, which is greater than the theoretical value. A search was made for γ-radiation down to 0·5 eMV and for delayed emission of electrons by the CaF_2 after bombardment, with negative results in each case. AUTHORS.

***1107. Installation of a Cyclotron. Y. Nishina, T. Yasaki and S. Watanabe.** *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 854. *pp.* 1658–1668, *Nov.*, 1938. *In English.*—The construction and operation of a cyclotron delivering 50 μA of 3 eMV deuterons is described. The field coils absorb 77 A at 400 V to give a field of 12,800 oersteds. Details of the vacuum chamber and the h.f. supply are given together with photographs of the apparatus. F. C. C.

***1108. Cyclotron and Its Applications. J. D. Cockcroft.** *Journ. Sci. Instruments*, 16. *pp.* 37–44, *Feb.*, 1939.—Discourse given at the Physical Society's 29th Annual Exhibition, 1939.

***1109. Operation of Spark-Counters. H. Greinacher.** *Zeits. f. techn. Physik*, 19. 12. *pp.* 592–594, 1938.—A spark-counter employing a gas-filled triode as a relay is described. The counting vessel is approximately in the form of a cone with the apex at the anode and the base at the kathode. The height and diameter are of the order of 0·5 mm. T. I. J.

***1110. Cause of Breakdown in Discharge Counters. R. Schade.** *Zeits. f. techn. Physik*, 19. 12. *pp.* 594–597, 1938.—The process of breakdown in the discharge counter is traced to static fluctuations in the electron emission from the kathode. According to this the discharge should break down, if for a time, which is greater than the mean time of transit of the electron, no electron is emitted from the kathode. To explain the results observed by Werner on this basis it must be assumed that the electron emission from the kathode arises photoelectrically. T. I. J.

***1111. Counter Amplifier with Variable Reduction Ratio. P. Weiss.** *Phys. Zeits.* 40. *pp.* 34–37, *Jan.* 1, 1939.—A description is given of a simple counter amplifier for simple impulses. The resolving power is $1·5 \times 10^{-3}$ sec. at reduction ratios from 1 : 1 to 40 : 1 or higher. At a ratio of about 8 : 1 a further simplification can be obtained by using a glow lamp in place of the third thyratron. Replacement of the initial thyratron by several stages with electronic valves gives an arrangement which, on account of its high reduction ratio of 40 : 1 or more, is specially suited for rapid impulses, *e.g.*, in radioactive measurements. The resolution is about 5×10^{-5} sec. L. A. W.

***1112. Apparatus for Determining the Resolving Power of Reducing Counters. P. Weiss.** *Phys. Zeits.* 40. *pp.* 37–39, *Jan.* 1, 1939.—A description is given of an arrangement for the determination of the resolving power of reducing counters, consisting of a generator giving pairs of impulses. The interval separating the two impulses of a pair can be regulated between 10^{-2} and 10^{-4} sec. The generator can also be made to give a succession of single impulses, the frequency being variable. An example of the use of the instrument is quoted. L. A. W.

***1113. Mechanism of Geiger Counter. A. N. May.** *Phys. Soc., Reports*, 5. *pp.* 390–401, 1938.

***1114. Sensitivity of a Geiger Counter to a Narrow Beam of γ-Rays. D. L. Jorgensen.** *Rev. Sci. Instruments*, 10. *pp.* 34–36, *Jan.*, 1939.—The sensitivity of cylindrical Geiger-Müller counters is investigated with respect to variation of (1) the position of incidence on the counter of a narrow beam of γ-rays with different potentials applied to the counter; (2) the applied potential for different modes of exposure to the γ-ray source; (3) the position of the γ-ray beam both along the axis of the tube and transversely across a mid-section. The slope of the "counting plateau" is shown to be due to increase of sensitivity near the ends of the tube, and the counting rate is roughly proportional to the area of the tube intercepted by the γ-ray beam. E. E. W.

***1115. Geiger Point Counters. B. Dasannacharya and A. C. Seth.** *Phil. Mag.* 27. *pp.* 249–257, *Feb.*, 1939.—The different possibilities are shown whereby the functioning of a point counter can be influenced by the resistances in the counter circuits. The alterations in the arrangements for observations of counts not mentioned in the investigation by Dasannacharya and Moorthy [see Abstract 2214 (1937)] are given. The axial dip caused by the failure of a counter due to the large leak resistances connecting the central needle electrode to the earth, to amplify the current, is investigated for pressures of 1·58 cm., 1·0 cm., 0·4 cm. and 2·4 cm., and curves are given for the first two pressures mentioned. The curves for the less amplified counts are also given, and it is shown that the dip is connected with the number of unamplified counts caused by insufficiency of amplification. It is shown that the leak resistance R_c brings about vast changes in the number of counts recorded, depending also on the number of ionising agencies entering the counter got either by moving the radiation source away from the axis at right angles or away from the counter along the axis. Finally, the rôle of the resistance R_b connecting the battery to the plate is shown to be the same as that of R_c. AUTHORS.

***1116. Recording Ionisation Chamber—D.C. Amplifier System for Artificial Radioactivity Decay Studies. S. W. Barnes.** *Rev. Sci. Instruments*, 10. *pp.* 1–5, *Jan.*, 1939.—A simple device is described which photographically records ionisation currents for periods of 12 to 30 hr. without attention, and allows measurements of small ion currents to be made much more accurately than by visual galvanometer observations. A synchronous motor-driven contactor actuates, by relays and by compressed air, the light sources, the camera film, and a device which moves the radioactive sample over the ionisation chamber window and away from it at fixed intervals of time. N. M. B.

See also Abstracts 973, 1058, 1135, 1148, 1165.

RADIATION.

ABSORPTION.

1117. Determination of Extinction Coefficients with a Hydrogen Lamp. H. Stücklen. *J.O.S.A.* 29. *pp.* 37–39, *Jan.*, 1939.—A modification of Henri's method for measuring extinction coefficients photographically at visible and u.v. wave-lengths is described. It employs a light source giving a continuous spectrum and can thus detect narrow bands often

overlooked if a spark source is used. The accuracy obtained is satisfactory. C. B. A.

***1118. Christiansen Optical Filter. W. Geffcken.** *Kolloid Zeits.* 86. *pp.* 55–60, *Jan.*, 1939.—The construction of the Christiansen dispersion filter is described, and a review is given of the theory underlying its action, with special attention to the size of the glass-particles. This is followed by consideration of its use as a monochromator, (*a*) to give maximum illumination, (*b*) to give maximum intrinsic brightness. A. C. M.

See also Abstract 1143.

COLORIMETRY.

See Abstracts 1202 and

615B. Artificial Daylighting for Colour Grading of Agricultural Products. D. Nickerson.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

1119. Possible Method of Measuring Weak Heterogeneous Magnetic Fields. W. Heller and J. Rabinovitch. *Comptes Rendus*, 207. *pp.* 1088–1090, *Dec.* 5, 1938.—The birefringence of a colloidal solution of Fe ("electroferrol") is sensitive to magnetic field variations and the possibility of using this property for measuring heterogeneous magnetic fields of the order of 5 G is suggested. The same solution may be used for field strengths up to 200 G but for larger field strengths other solutions are available, the preparation of which is described. H. J. H. S.

1120. Faraday Effect in D_2O. F. Gabler. *Phys. Zeits.* 40. *pp.* 32–33, *Jan.* 1, 1939.—The magnetic rotation of the plane of polarisation in H_2O, D_2O and a mixture of the two is investigated as a function of the temperature T in the interval 15° to 97° C. Using the known Verdet constant V for H_2O, the absolute values of V can be expressed by an equation of the form $V = a - bT - cT^2$ where a, b and c are constants. For D_2O at 20° C. and wave-lengths of 5416 and 5893 Å the respective values of V are 0·01483 and 0·01254 min. per gauss. cm. (probable error 3 units in the last place). The measurements give no evidence of the presence of HOD molecules. L. A. W.

See also Abstracts 1355, 1394.

EMISSION.

1121. Scattering and Splitting of Photons on the Non-Linear Field Theory of Born and Infeld. S. Tomonaga and M. Kobayasi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 852. *pp.* 1643–1649, *Nov.*, 1938. *In English.*—The total cross-section for the coherent scattering of photons by the nuclear field is calculated and found to be proportional to the cube of the atomic number of the scattering nucleus and to increase as the fourth power of the energy of the incident photon, whereas on the Dirac theory of the electron it is proportional to the fourth power of the atomic number. The total cross-section for the splitting of an incident photon into two photons by the field of a nucleus is calculated and found to be proportional to the square of the atomic number and to increase as the sixth power of the energy of the incident photon. N. M. B.

1122. Photon Equations. J. Roubaud-Valette. *Comptes Rendus*, 207. *pp.* 1177–1180, *Dec.* 12, 1938.—From the theory of a five-dimensional

universe equations for a composite particle are deduced which satisfy the conditions required by a photon. N. M. B.

1123. Relations between Photon and Heavy Electron Theory. M. A. Tonnelat. *Comptes Rendus*, 207. *pp.* 1180–1182, *Dec.* 12, 1938.—A comparative examination of the mathematical relationships of available equations. N. M. B.

1124. Coordination of Heavy-Electron Equation, Kemmer and Klein-Gordon Equations, and de Broglie Photon Equations. A. Proca. *Comptes Rendus*, 207. *pp.* 1182–1184, *Dec.* 12, 1938.—The conditions for deducing the other equations from a general symbolic equation are examined and specified. N. M. B.

1125. Electromagnetic Equations of the Photon Theory. G. Petiau. *Comptes Rendus*, 208. *pp.* 167–169, *Jan.* 16, 1939.—A mathematical extension of de Broglie's photon theory. N. M. B.

1126. Table and Graph for Black-Body Radiation Calculations. Z. Miduno. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 951–961, *Nov.*, 1938. *In English.*—Tabulated data are given to assist with the calculation of the proportion of energy E_λ, or the number of photons n_λ, emitted by a black-body radiator at any given temperature and over any specified range of wave-lengths. In deriving these data Planck's formula for the energy distribution has been used with a value of 14490·297 for C_2, but the factors are included which enable the data to be readily modified should it be desired to use a somewhat different value for C_2. A nomograph is given from which values of E_λ and n_λ correct to a few per cent can be read. R. W. P.

1127. Radiation Laws Describing Emission of Photons by Black Bodies. A. G. Worthing. *J.O.S.A.* 29. *pp.* 97–100, *Feb.*, 1939.—Starting with a relation showing the temperature volume changes for black-body radiation which is undergoing an adiabatic change, it is shown how photon laws which correspond one by one with known radiant energy laws may be derived. In all instances, excepting two, namely $\lambda_m' T = \text{const}$ and $\nu'_m T = \text{const}$, the photon relations differ from the corresponding radiant energy relations chiefly by having a power of T decreased by one, a power of λ increased by one, or a power of ν decreased by one. The entropy of black-body radiation is strictly proportional to the number of photons involved. A table is given which includes values in common units for the collective groups of constants entering the various photon and radiant energy equations mentioned in the paper. [See following Abstract.] AUTHOR.

1128. New λT Relations for Black-Body Radiation. A. G. Worthing. *J.O.S.A.* 29. *pp.* 101–102, *Feb.*, 1939.—When the temperature of a black-body is such that the maximum spectral efficiency of production of radiant energy occurs at a given wave-length there also occurs at that wave-length, both the maximum spectral rate of production and the maximum spectral efficiency of production of photons. The particular wave-length involved is the effective wave-length for the total radiation, which is defined as the wave-length at which, for a given temperature, the percentage rate of increase in spectral radiancy with temperature is the same as for the total radiation from the black-body source. [See preceding Abstract.] AUTHOR.

***1129. Spectral Energy Distribution from High Pressure Mercury Lamp. F. Rössler.** *Ann. d. Physik*, 34. 1. *pp.* 1–22, *Jan.*, 1939.—Describes a careful re-determination of the spectral energy distri-

bution of the radiation from the u.v. standard described by Krefft, Rössler and Rüttenauer [see Abstract 1193 (1937)]. The range of wavelengths covered is 0·2 to 6 μ and the emission due to the lines is separated from that due to the continuous spectrum. The radiation from the quartz was measured separately. J. W. T. W.

1130. Possible Origin of Soft Cosmic Rays at Sea-level. B. Ferretti. *N. Cimento*, 15. *pp.* 421–424, *July*, 1938.—On the hypothesis that the heavy electron disintegrates with a mean life of about 10^{-6} sec., into an electron and a neutrino, the energy spectrum of the soft component of cosmic rays at sea-level is in approximate agreement with experiment. F. C. C.

1131. Cosmic Rays. W. Heitler. *Phys. Soc., Reports*, 5. *pp.* 361–389, 1938.

1132. What are Cosmic Rays? W. F. G. Swann. *Frank. Inst., J.* 226. *pp.* 757–796, *Dec.*, 1938.—Following a brief historical survey of the development of the theory of the energy losses undergone by cosmic rays in penetrating the atmosphere and matter in general, the author describes experiments on shower-production in a mine at a depth of 100 ft. which are consistent with the conclusion that the showers there observed are due to a soft component which is secondary to a penetrating component. Experiments on the extent to which rays observed at sea-level are associated with one another are described. A review is given of the possibilities inherent in the theories of energy-loss (chiefly those of the author) developed prior to the application of the quantum theory to the problem, and is followed by a demonstration of a theory showing how the phenomena commonly associated with a hard and a soft component follow from the assumption of a single primary component, with a suitably chosen distribution component, which undergoes successive large energy losses. In conclusion, theories of the origin of the rays are discussed. D. H. F.

1133. Present Status of Theory of Effect of Earth's Magnetic Field on Cosmic Rays. M. S. Vallarta. *Frank. Inst., J.* 227. *pp.* 1–29; *Disc.*, 29–35, *Jan.*, 1939.—The present communication is intended to cover a brief summary of the results obtained through analysis of the motion of charged particles in the earth's magnetic field and includes the following topics: (*a*) The main cone, in any direction within which particles of a given energy may arrive at a given point on the earth. Latitude and azimuthal effects. Special cases of the latter: north-south and east-west asymmetries. The ratio of positive and negative primaries. (*b*) The shadow cone, outside of which no particles of a given energy may arrive at a given point on the earth. (*c*) The penumbra, *i.e.*, the region intermediate between the main cone and the shadow cone in which certain directions are allowed and the others forbidden. (*d*) The eccentricity of the earth's magnetic centre and the longitude effect. The position of the earth's magnetic centre. The earth's magnetic quadripole. (*e*) The earth's magnetic field and the galactic rotation effect. (*f*) The sun's magnetic field and some of the consequences of its existence. The knee of the latitude effect. Solar diurnal and annual variations. (*g*) Preliminary communication on magnetic storms and cosmic-ray intensity. **W. F. G. Swann, T. H. Johnson** and **S. A. Korff** contributed to the *Discussion*. AUTHOR.

1134. Geomagnetic Effects and Cosmic-Ray Investigation. T. H. Johnson. *Frank. Inst., J.* 227. *pp.* 37-58, *Jan.*, 1939.—Sum-

marising the evidence as to the nature of the primary cosmic radiation the following points stand out. (1) The balloon flight data of Bowen, Millikan and Neher show that the soft component is practically 100% electrically charged. As far as the asymmetry experiments go these rays are equally positive and negative though this point is not well established. (2) The penetrating component which seems to consist of equal numbers of positive and negative heavy electrons, is secondary to primary rays of higher energy. These primaries are, within experimental error, entirely positive. (3) The radiation in external space must be electrically neutral. Hence it is sufficient to assume that the positive primaries of the penetrating component are more massive than the negative rays which neutralise them. A most reasonable assumption would be that this component consists of protons or heavier ions, neutralised by free electrons. The completely electrical character of the primary radiation (the absence of photons and neutrons) gives some basis for hypotheses regarding their origin. If the radiation has passed through a stellar atmosphere before reaching the earth of even a fraction of 1m. of water equivalent it would have generated a large number of neutral rays. The absence of such rays leads us to suppose either (*a*) that the rays have been generated in vacuous space or (*b*) that the electrically charged particles have been detained in this region of space by a galactic magnetic field, whereas the neutral rays have passed freely out. Because of the difficulty of envisaging mechanisms for the production of rays in vacuous space the latter hypothesis seems preferable. The degree to which an equilibrium with matter has been reached will then have to be inferred from the proportion of soft and penetrating rays in the primary beam. The view developed here as to the nature of the primary radiation invokes the production of heavy electrons when high-energy protons collide with matter. Whether or not this is a welcomed suggestion must be left to the theorist to decide. AUTHOR.

1135. High-Energy Processes Due to Cosmic Rays. E. M. Schopper and E. Schopper. *Phys. Zeits.* 40. *pp.* 22–26, *Jan.* 1, 1939.—Tracks of heavy particles and nuclear disruptions due to cosmic rays are directly recorded in the sensitive layer of photographic plates. The exposures are taken at various heights, particularly in the stratosphere, the plates being carried by unmanned balloons of special design. The energy and nature of the particle in question can be deduced from its range in the photographic layer and from the grain density of the track. In addition to tracks of protons, tracks ascribable to α-particles and atomic nuclei of high energy are observed. Nuclear disruptions involving several particles—in one instance (taken on the Jungfraujoch at 3400 m.) 14 particles—are recorded. L. A. W.

1136. Latitude Effect for Cosmic-Ray Showers. G. Occhialini. *Comptes Rendus*, 208. *pp.* 101–103, *Jan.* 9, 1939.—Shower-counting with an assembly of four counters, under various thicknesses of Pb, was carried out on a voyage between Bahia and Trieste (latitude 14° S. to 44° N. approx.). There was no difference between the shapes of the transition curves at different latitudes, but at the higher latitudes the shower-rates were about 3% higher than those in the equatorial regions, compared with a difference of 10% in the counting rates of a single counter shielded with 4·5 cm. of Pb. D. H. F.

1137. Identity of Hoffmann "Bursts" with Electron Showers Produced by Cosmic Rays. A. Dauvillier. *Comptes Rendus*, 207. *pp.* 1392–1393, *Dec.* 27, 1938.—Experiments are described showing the

Hoffmann " bursts " [see Abstract 1186 (1937)] to be identical with the showers of positive and negative electrons detected by means of counters and Wilson chambers. C. A. S.

1138. Large Cosmic-Ray Showers. P. Auger, R. Maze, P. Ehrenfest, Jr. and A. Fréon. *J. de Physique et le Radium*, 10. *pp.* 39–48, *Jan.*, 1939.—A comprehensive series of experiments was conducted to elucidate the properties of the showers detected by counters placed several metres apart. The investigations included counter-controlled cloud-chamber experiments and were carried out at sea-level and at altitudes of 2900 and 3500 m. It is concluded that there are cascade showers due to electrons of very high energy ($> 10^{13}$ eV). There may be several regions in such showers where the density of the rays is much greater than the average for the whole shower; such groups contain particles of high energy having an angular spread of very few degrees. The showers contain a component capable of penetrating 15 cm. of Pb and which appears, from the evidence of cloud tracks, to excite vigorous nuclear reactions. D. H. F.

1139. Number of Secondary Electrons Accompanying Penetrating Component of Cosmic Rays in Different Materials. J. Clay and F. J. H. Duvergé. *Physica*, 6. *pp.* 171–173, *Feb.*, 1939. *In English.*—Threefold coincidences were counted without Pb and with 5 cm. Pb between the counters, under a thick layer of H_2O, Pb or Fe. The number found in this way was (50 cm. H_2O) 4·5%, Pb 3% and Fe 3·8%. For 10 m. H_2O the number was 2%. Authors.

1140. Decay of Penetrating Cosmic Rays in Different Directions. J. Clay, K. H. J. Jonker and J. T. Wiersma. *Physica*, 6. *pp.* 174–176, *Feb.*, 1939. *In English.*—The distribution of the penetrating radiation around the vertical was measured, together with the decrease and the number of accompanying secondary electrons. According to this the time of decay of the particles would be $\tau = 8 \times 10^{-6}$ sec. There is no asymmetry around the vertical. The decrease in the more oblique directions is smaller. Authors.

1141. Penetrating Cosmic Rays in Water and Rock. P. H. Clay, A. v. Gemert and J. Clay. *Physica*, 6. *pp.* 184–204, *Feb.*, 1939. *In English.*—The results are given of measurements carried out with four different counter systems and with an ionisation chamber, down to 450 m. water in the Sörfjord near Bergen. They are compared with earlier results. The intensity of the primaries under 60 to 450 m. water can be expressed by $I = C\,h^{-1,93 \pm 0,01}$. From 10 to 60 m. water the decrease is smaller on account of the decay of the particles in the atmosphere which affects especially the number of particles of lower energy. This is the reason why the decrease in this region deviates from the above equation. From the deviation a value is calculated for the mean lifetime of the particles, $\tau \sim 2 \times 10^{-6}$ for $3 \times 10^9 < E < 12 \times 10^9$ eV. The primary rays appeared mostly to be ionising particles down to 450 m. at least. The absorption appears to be governed by the electron density of the material and not by its mass density. The amount of secondary soft radiation in relation to the hard radiation increases with depth, *i.e.*, with the mean value of the energy of the rays. The ionisation measurements show an excess of soft secondary radiation in two regions (200 and 350—400 m.) which coincides with fluctuating ionisation currents, presumbably due to a separate kind of penetrating radiation. Authors.

1142 U.V. Emission during Coagulation. A. Rabinerson and M. Philippov. *Comptes Rendus*, 208. *pp.* 35–37, *Jan.* 3, 1939.—It has been shown that the coagulation of the hydrophobic sols $Fe(OH)_3$ and V_2O_5, and the hydrophilic sodium oleate, is accompanied by the emission of u.v. radiation. The radiation was detected by means of a combination of a Geiger-Müller counter and a photo-cell. Biological investigations show that the radiation emitted during coagulation of colloids is identical with mitogenetic radiation. [See Abstract 3215 (1938).] A. J. M.

See also Abstracts **1041, 1085, 1091, 1366, 1413, 1414** and
606B. Production of Light. H. Krafft.
607B. Mercury Vapour Lamp. R. Rompe and W. Thouret.
608B. H.P. Mercury Vapour Lamps with Multiple Electrodes. J. Kern and H. Krafft.

FLUORESCENCE AND PHOSPHORESCENCE.
LUMINESCENCE AND AFTERGLOW.

1143. Absorption and Fluorescence of Chrysene Molecule. K. S. Krishnan and P. K. Seshan. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 487–498, *Nov.*, 1938.—Chrysene crystal is monoclinic, and as usually prepared is in the form of a flake parallel to (001). The molecular planes are inclined at 79° to (001), and their intersections with (001) make angles of $+\phi$ and $-\phi$ with the *b*-axis, where $\phi = 29\frac{1}{2}°$. The fluorescence of the crystal was excited by the 3650 group of lines of the Hg arc, incident normally on the flake, and was analysed in the forward direction for its polarisations and intensity. The following results were obtained: (1) Whether the incident vibrations are along *a* or along *b*, the *a* vibrations in forward fluorescence are much weaker than the *b* vibrations, the ratio of their intensities being 0·40, which is nearly equal to $\tan^2\phi$. From this it is concluded that when the incident light-vibrations are along the normal to the plane of a molecule there is hardly any fluorescence excited in it, and that it is only vibrations in the plane that excite fluorescence. (2) With a crystal thick enough to absorb *completely* the exciting radiations, the intensities of forward fluorescence excited by the *a* and the *b* vibrations separately, are practically equal. From this observation it follows that the absorption coefficients for the *a* and the *b* vibrations should bear the ratio $\tan^2\phi : 1$. This conclusion is verified by direct measurements on the absorption coefficients. The obvious interpretation of this result is that when the incident light-vibrations are along the normal to the molecular plane there is hardly any absorption; and it is only vibrations in the plane that are absorbed. (3) The relation between fluorescence and absorption is discussed. AUTHORS.

1144. Sensitised Fluorescence of Potassium. E. H. Krause. *Phys. Rev.* 55. *pp.* 164–169, *Jan.* 15, 1939.—A mixture of K vapour and Hg vapour contained in a tube fashioned after the Cario-Lochte-Holtgreven Na vapour lamp was radiated by light from a water-cooled Hg arc. The resulting fluorescence radiation contained K lines as well as two of the three known K_2 absorption bands and a new band with maximum at 5721 Å. On exposure of the mixture to light from a hot Hg arc or to light having all wave-lengths shorter than 2800 Å filtered out, the fluorescence was eliminated. This indicated that the excitation was caused by absorption of 2536 Å by the Hg. Absorption of the 2536 Å Hg line raises the Hg atom to the 6^3P_1 state, having an energy of 4·86 V. The ionisation

potential of K is 4·32 V.; thus in a collision of the second kind, the excited Hg atom has enough energy to ionise the K atom. There was no evidence of a K emission from an energy state in the continuum equal in energy to the Hg 6^3P_1 or 6^3P_0 states. There were, however, two strong lines in fluorescence which could not be ascribed to the usual K energy levels nor to any probable impurity. To test whether or not ionisation of K actually takes place, a filament was introduced into the tube to supply electrons. A large increase in intensity of the fluorescence of K lines was obtained with the hot filament. It was furthermore found that the intensity increased with filament temperature. AUTHOR.

1145. Excitation of Phosphors by Collisions of the Second Kind. K. Sommermeyer. *Zeits. f. phys. Chem.* 41. *Abt.B.* 6. *pp.* 433–440, 1938.—A zinc-silicate phosphor was caused to luminesce by surface combination of (*a*) H atoms, and (*b*) N atoms, to form molecules. The quantum yields of the processes were determined, and were (*a*) for H, $0{\cdot}5 \times 10^{-5}$ light-quanta per recombination; (*b*) for N, not precisely determined, but not more than for (*a*). A. C. M.

1146. Decay Times of ZnS-CdS-Cu Phosphors after Excitation with Kathode Rays. G. Wollweber. *Ann. d. Physik*, 34. 1. *pp.* 29–40, *Jan.*, 1939.—The method is based on the parallelism alleged to exist between change of dielectric constant and phosphorescence and employs oscillating circuits and a kathode-ray oscillograph. Results with varying Cd and Cu content are given. J. E.

1147. Electrical Effects in ZnS Phosphors Activated with Copper. F. Goos. *Ann. d. Physik*, 34. 1. *pp.* 77–95, *Jan.*, 1939.—A study, mainly qualitative, of the photoelectric properties of phosphorescent ZnS and their relation to other optical properties. The alteration of the dielectric constant under excitation shows a dependence on previous illumination, and, as previously found, on the frequency of the alternations in alternating fields. In constant electric fields there is a marked difference between thick layers not fully excited, and thin layers, fully excited. The dark current in the former case obeys Ohm's law while notable deviations are observed in the latter. This result enables a distinction to be made between the primary current and a secondary current. In ZnS partially decomposed by rays or by light the shift of excitation distribution towards the red is taken to be due to the liberation of free Zn. In thin layers when the applied field is parallel to the light there is a directional effect in the secondary current which rises exponentially with the voltage and decreases with increasing frequency. It appears that the alteration of dielectric constant under illumination, the secondary current and the directional effects are linked with phosphorescence, while the primary current has no such connection. J. E.

1148. Decomposition of ZnS by Light and by α-Rays. E. Streck. *Ann. d. Physik*, 34. 1. *pp.* 96–112, *Jan.*, 1939.—The decrease of excitability of radioactive zinc sulphides with ageing is found to depend on the original excitability. It is concluded that the phosphorescent centres are therefore different for α-ray-and light-excitation. In some thoriated preparations the ageing as regards photoluminescence is far more rapid than the radioluminescence and the long-duration phosphorescence shows a more marked ageing decrease than the short duration. The brighter the initial luminescence the more does the decay rate increase with ageing, a fact which is taken to indicate that α-radiation liberates Zn atoms. A close relationship is found between the change of dielectric

constant with illumination and the phosphorescence, both being connected with the amount of free Zn. The effects of different binders on the blackening under irradiation were studied with results which are claimed to be of value in their choice. Blackening is found to be reversible and with recovery comes regeneration of the original dielectric constant. Pure ZnS can also be blackened by u.v. light and becomes de-blackened on standing, the processes being repeatable many times. J. E.

1149. Energy Transformation by Luminescent Materials. M. Schön. *Zeits. f. techn. Physik*, 19. 11. *pp.* 361–364, 1938. *Phys. Zeits.* 39. *pp.* 940–943, *Dec.* 15, 1938.—Gives an account of the mechanism of the luminescence in crystalline phosphors. By means of a model the action which takes place when energy is absorbed and the process by which it is re-emitted are explained. Reference is made to the excitation of crystalline phosphors by electron bombardment. J. W. T. W.

1150. Rise and Decay of Luminescence in Phosphors. A. Schleede and B. Bartels. *Zeits. f. techn. Physik*, 19. 11. *pp.* 364–369, 1938. *Phys. Zeits.* 39. *pp.* 936–940, *Dec.* 15, 1938.—Part I contains a general description of the nature of the luminescence excited by u.v. light or by electron bombardment in the case of certain phosphors, viz. ZnO, ZnS, ZnS–Cu, ZnS–CdS–Ag, Zn_2SiO_4 and $CaWO_4$. Part II describes an investigation of the rate of rise and decay of the luminescence. The exciting light (or electron stream) was caused to act for a given time, 0·2 sec., 0·008 sec. and 20 μ sec. respectively and by means of a photo-cell and oscillograph the rise and decay of the light from the material was found for each of the substances enumerated above. For u.v. excitation the two longer periods were used, for the electron bombardment the second and third of the periods mentioned. The oscillograph records are reproduced. J. W. T. W.

***1151. Activation and Decay of Luminescent Zinc Silicate. N. C. Beese.** *J.O.S.A.* 29. *pp.* 26–28, *Jan.*, 1939.—A transmission phosphoroscope is described that gives information on the activation and decay rates of luminescent powders, and indicates the relative amounts of fluorescent and phosphorescent light. AUTHOR.

***1152. Light Output and Secondary Emission Characteristics of Luminescent Materials. S. T. Martin and L. B. Headrick.** *J. of Applied Physics*, 10. *pp.* 116–127, *Feb.*, 1939.—Light output and screen potential data are given for zinc sulphide, calcium tungstate, willemite and several other silicate phosphors sprayed (from suspension) on Nonex glass and bombarded by electrons. The bombarding voltage range from 0·5 to 10 kV is covered. The limiting potentials of willemite and other zinc silicate screens fall in the range from 6 to more than 10 kV depending on the conditions of exhaust and preparation. The limiting potentials of two zinc sulphides fall in the range from 6 to 9 kV while calcium tungstate has a limiting potential usually less than 5 kV. Light output as a function of screen voltage over the range from 0·5 to 10 kV is shown to follow a law of the form : $L = Af(i)V^n$, where L is intensity of light, i is current density, V is electron energy at the screen in kV, and A is a constant. The data show that $n < 2$ for willemite or other zinc silicates, $n = 2$ for sulphides, and $n > 2$ for calcium tungstate and a fused layer of willemite. Analysis and comparison of the light output current density characteristic and the persistence characteristic shows that a definite relation exists between them in the case of silicate phosphors. The function of current density may

be represented by

$$f(i) = A i[1 - \{a/(a+b)\}e^{-/\alpha B i} - \{b/(a+b)\}e^{-\gamma/Bi}].$$

The constants α and γ are those appearing in the persistence characteristics of the material as : $L = \{a/(a+b)\}e^{-\alpha t} + \{b/(a+b)\}e^{-\gamma t}$, a formula which expresses well the persistence of silicate screens. AUTHORS.

*1153. **Automatic Recording Spectroradiometer for Kathodoluminescent Materials. V. K. Zworykin.** *J.O.S.A.* 29. *pp.* 84–91, *Feb.*, 1939.—An automatic recording spectrophotometer for the visible, especially adapted for the study of kathodoluminescent materials, is described. It consists of a demountable light source and an interrupter, a glass monochromator with compensation for the variation of the dispersion with wave-length, a photoelectric electron multiplier, a signal amplifier stablised by negative feedback, and a motor drive amplifier controlling the deflection of the recording head. The wave-length scale is made linear by the introduction of a spiral cam of appropriate form. The system is distinguished by high sensitivity (usable for sources emitting one millilumen/cm^2.), high speed (1¼ minutes for a record), linear wave-length scale, high stability and easy adjustment. AUTHOR.

1154. Photographic Control of Luminescence Excited by X-Rays. C. Piffault. *J. de Radiologie et d'Électrologie*, 22. *pp.* 586–591, *Dec.*, 1938.—Under the action of X-rays various bodies are fluorescent, this property being utilised in the manufacture of radiographic screens. Various methods have been used to detect and measure this property and the author has used the photographic method, when fluorescence is excited by a Holweck X-ray tube. Various photographic records are shown for rock-salt, aluminium, vaselin, distilled water, ferrous sulphate and cholesterine. B. J. L.

1155. Emission from the Ends of Luminescent Tubes. L. Dunoyer. *Comptes Rendus*, 207. *pp.* 1095–1097, *Dec.* 5, 1938.—The author gives general formulæ for determining the intensity of the light emitted at the end of a cylindrical photoluminescent tube which receives primary radiation either through the other end or through the cylindrical surface. W. S. S.

1156. Emission from the Ends of Luminescent Tubes. L. Dunoyer. *Comptes Rendus*, 208. *pp.* 93–95, *Jan.* 9, 1939.—Briefly discusses formulæ [see preceding Abstract], dealing with incandescent or electro-luminescent fluids, and photoluminescent tubes, cylindrically or end-excited. From a comparison of these two methods, it is concluded that, for the study of gases with a small degree of absorption, the cylindrically excited tubes are the better. [See following Abstract.] R. C. F.

1157. Emission from the Ends of Luminescent Tubes. P. Lafné and R. Servant. *Comptes Rendus*, 208. *pp.* 275–276, *Jan.* 23, 1939.—Deals briefly with the part played by the reflections from the tube walls, which have not been taken into account by Dunoyer [see preceding Abstract]. R. C. F.

See also Abstracts 1257 and
605B. Luminescent Materials for Light Production. A. Rüttenauer.

INTERFERENCE, DIFFRACTION AND SCATTERING.

1158. Colours of Mosaic Powder Films. A. H. Pfund. *J.O.S.A.* 29. *pp.* 10–15, *Jan.*, 1939.—An examination of the origin of the colours

observed when white pigment particles (TiO, ZnS, etc.), are deposited on glass in a layer one particle deep. A. H.

1159. New Method of Demonstrating Stationary Light Waves. H. Jäger. *Ann. d. Physik*, 34. 3. *pp.* 280–296, *Feb.*, 1939.—After a review of earlier work, full details are given of apparatus by means of which stationary waves of u.v. light may be quantitatively demonstrated. The standing waves are detected by means of the photoelectric effect of a very thin metal film on the lower surface of a quartz plate. The incident beam of light passes through this metal layer and is normally reflected from a lower parallel mirror surface which acts as anode for the photo-cell. An intensity control is incorporated whereby the amplitudes of the recorded standing waves are maintained at an almost constant value. The various sources of error and means of overcoming them are discussed. A. G. Q.

1160. Testing Planeness of Surface by Haidinger's Rings. O. Schönrock. *Zeits. f. Instrumentenk.* 59. *pp.* 31–40, *Jan.*, 1939.—The author develops the theory of an interferometer method for determining the deviation from planeness of the surface of a glass plate without reference to a plane liquid surface. W. S. S.

1161. Ghosts in Lines from Diffraction Gratings. F. Paschen. *Ann. d. Physik*, 34. 2. *pp.* 130–135, *Jan.*, 1939.—In higher orders, strong and sharp spectral lines from a large Rowland concave grating are accompanied by very close symmetrically arranged lines separated from them by about 0·01 Å. From measurements of this separation, it is concluded that these lines are ghosts which originate in a division of the grating surface into several parts, which perhaps correspond to definite periods during the ruling process, possibly connected with the control of the machine. C. B. A.

1162. Light Scattering in the Branch of the Rayleigh Line of CS_2. J. Pniewski. *Acad. Polonaise Sci. et Lettres, Bull.* 3–5*A*. *pp.* 136–142, *March–May*, 1938. *In German.*—The scattering of light in the branch of the Rayleigh line is investigated using a spectrograph of high dispersion (1·8 Å/mm. in the blue region 4358 Å), the source of light being two large Hg vapour lamps. The temperature is controlled by placing the apparatus in a thermostatically controlled room. The intensities of lines in the Stokes and anti-Stokes part of the band are measured and compared with the calculated values assuming free rotation of the molecules, and the impossibility of ascribing the whole of the branch to the rotation of the molecules is shown. The possibility of restricted rotation is considered. F. J. L.

1163. Light Scattering in Anisotropic Media. H. Mueller. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 267–274, *Nov.*, 1938.—The theory of Brillouin scattering of light in an optically anisotropic medium is developed. The influence of a uniform elastic strain on the intensity and the depolarisation factors of the light scattered by a glass are calculated. These quantities change rapidly when the forced birefringence reaches a magnitude of the same order as the optical fluctuations within the glass. They reach definite saturation values for large strains. The results are analogous in many respects to those observed for scattering in a graphite sol under the influence of a magnetic field. Author.

1164. Scattering of Light in a Rochelle Salt Crystal. L. Sibaiya. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 393–396, *Nov.*, 1938.—This study of the structure of the Rayleigh lines scattered by a Rochelle salt

crystal affords definite experimental proof of the presence of Debye waves in solids. A. H.

1165. Scattering of Radiation by the Magnetic Electron. W. Franz. *Ann. d. Physik*, 33. 8. *pp.* 689–707, *Dec.*, 1938.—Formulæ are derived for the scattering of light by an electron magnetised in a definite direction and lead to an extension of the formula derived by Klein and Nishina for a spin-less Dirac electron by terms dependent on the spin. Application of the formulæ to magnetised Fe indicates that it may be possible to demonstrate experimentally the influence of the direction of magnetisation on the intensity of twice scattered X- or γ-rays. J. E. K.

See also Abstracts 1121, 1183, 1185, 1186, 1190, 1196, 1255, 1313, 1314, 1315, 1327.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

1166. Advances in the Theory of Photography. E. W. H. Selwyn. *Phys. Soc., Reports*, 5. *pp.* 191–201, 1938.

1167. Supersaturated Solutions of Metallic Silver. R. E. Liesegang. *Zeits. f. wiss. Phot.* 37. *pp.* 218–220, *Sept.–Oct.*, 1938.—When Ag salt solutions are reduced, the Ag first appears in the form of a supersaturated solution. The mechanism is briefly discussed and an attempt is made to determine the degree of supersaturation. H. J. H. S.

1168. Improved Fine-Grain Developer Formula. J. I. Crabtree and R. W. Henn. *Kodak Research Lab. Comm. No.* 695. *Phot. J.* 79. *pp.* 17–26, *Jan.*, 1939.—Describes the results of examinations which have led to a satisfactory developer formula giving a minimum loss of emulsion speed. Details of a fine-grain developer (DK-20) are given, which gives a decided graininess reduction, when compared with certain other developers, with an average speed loss of only 35%. This developer can be used as a universal developer, not only for miniature films, but for roll and cut films and plates, both for amateur and professional use. R. C. F.

1169. Graininess of Photographic Layers Produced by Irradiation with High-Energy Quanta. J. Eggert and E. Schopper. *Zeits. f. wiss. Phot.* 37. *pp.* 221–232, *Sept.–Oct.*, 1938.—Examines the effect on the graininess of photographic layers produced by radiations of different types, including normal light and X-rays. With reference to the graininess of developed layers it is found that two quantities are important—the average grain diameter and the grain distribution. The graininess for equal blackening increases with increasing grain diameter and with the deviation of the distribution from the normal value. Exposure to X-rays shows an increase in graininess with increasing quantum energy of the radiation. R. C. F.

1170. Measurement and Specification of "Grain" of Photographic Emulsions. V. Ronchi. *Ricerca Scientifica*, 2. *pp.* 588–596, *Nov.* 15–30, 1938.—The author and his collaborators have measured the resolving power of photographic emulsions by photographing interference fringes which in the interferometer used could easily be obtained with a fineness up to 400 to 500 fringes per mm. The variations of resolving power with wave-length, exposure time and conditions of development are briefly described. For comparing emulsion-developer combinations it is proposed to specify the average resolving power for densities between 0·1 and 0·6 and for variations in temperature and time of development such as occur in common practice. W. S. S.

1171. Local Sensitivity Differences in Photographic Plates. O. Paulsen and A. W. Reitz. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 504–507, *Nov.*, 1938.—It has been discovered from the determination of the depolarisation relationships in the scattered spectrum, that certain defects of photographic plates, which had previously been regarded as of arbitrary occurrence, possessed a systematic character which could, in consequence, be remedied. Experimental details with discussion of results are recorded for different emulsions, and illustrations are included for these systematic sensitivity differences in the films of Braunsiegel plates. H. H. Ho.

1172. Density of Under-Exposed Photographic Plates. Tien Kiu. *Comptes Rendus*, 207. *pp.* 1394–1396, *Dec.* 27, 1938.—In photographic photometry it is sometimes impossible, especially with feeble light sources, to work in the region of normal exposure. It is therefore important to know the form of the curve relating density and time of exposure in the under-exposure region of the curve. The author finds that if densities are plotted against times of exposure as abscissæ, rather than against the logarithms of these times, it is easy to interpolate with considerable precision. He points out that the curve cuts the time axis at a short distance on the positive side of the origin, showing that the latent image does not begin to be formed instantaneously. J. W. T. W.

1173. Characteristic Curves in the Colour Process. H. Keilich. *Zeits. f. wiss. Phot.* 37. *pp.* 195–218, *Sept.–Oct.*, 1938.—Theoretical expressions are derived for characteristic curves of importance in the colour process. The factors which affect these curves are examined experimentally. For white light, the curves show an initial small curvature followed by a pronounced curvature over the central region which then flattens out and becomes straight. For monochromatic radiation, the characteristics are linear, the slope varying with the colour. The gradation of a particular colour may be controlled by means of a suitable multi-layer emulsion. H. J. H. S.

***1174. Stereoscopic Photographs on Roll Films. O. Bender.** *Phot. Indust.* 37. *pp.* 58–60, *Jan.* 9, 1939.—Deals briefly with the more recent specifications for stereoscopic cameras using roll films, considering particularly those which take kinematograph films. R. C. F.

1175. Camera Error in Photogrammetric Mapping. I. C. Gardner. *Bureau of Standards, J. of Research*, 22. *pp.* 209–238, *Feb.*, 1939.—A portion of the errors in a map constructed from aeroplane photographs arises from differences between the actual performance of the camera and the postulated performance as defined by the calibration constants. The different sources of errors of this nature are enumerated and equations are derived showing the relation between errors in the calibration constants of the camera and the resulting errors in the map. Equations are given for resulting errors in the map arising from incorrect value of the calibrated focal length, distortion, and incorrect location of the principal point. Other sources of error in the camera, such as failure of the film to lie in a plane, the character of performance of the shutter, and imperfect filters are considered and their effects upon the image evaluated. Author.

***1176. Densitometer Employing an A.C. Amplifier. L. P. Tabor.** *J.O.S.A.* 29. *pp.* 32–34, *Jan.*, 1939.—The densitometer described is an application of the stable and reliable a.c. amplifying circuit to the problem of measuring photographic densities. A glow lamp, actuated by an oscillator and power amplifier, is used to obtain the pulsating light,

instead of the mechanical chopper that has been used in previous applications of this circuit. A circular area, $\frac{1}{8}$ in. in dia., is measured, and densities are read directly from a calibrated attenuator. AUTHOR.

1177. Air-Conditioning Arrangements in Large Photographic Works. W. Nauck. *Phot. Indust.* 36. *pp.* 1405–1407, *Dec.* 21, 1938.—Briefly describes the importance of air-conditioning in the manufacture of photographic materials, and discusses some of the modern methods of obtaining the desired results, it being stated that satisfactory air-conditioning is not possible without thermostatic control. R. C. F.

See also Abstracts 953, 1100, 1181, 1191, 1406.

PHOTOMETRY.

1178. Heterochromatic Photometry. A. Dresler. *Zeits. f. techn. Physik*, 19. 11. *pp.* 369–372, 1938.—The photometric measurement of light sources giving radiation of such a spectral distribution that the energy at wave-length λ is E_λ must be such that the intensity is given by the expression $c\int E_\lambda V_\lambda d\lambda$, where c is a constant (the mechanical equivalent of light) and V_λ is the relative luminosity factor (or visibility factor) of radiation at wave-length λ. The values of V_λ were agreed internationally in 1924 by the International Commission on Illumination, but certain researches in Germany and Russia have indicated a curve for V_λ which is markedly different from the international curve, the maximum being about 10 $m\mu$ nearer the red end. This change has not been confirmed by work in England and America. Another source of doubt arises from experiments tending to show that radiations of different spectral distributions do not obey the law of addition. No doubt both these problems are connected with the effects of field size and brightness on the response of the eye to radiation at different parts of the spectrum. Two methods of resolving the difficulty seem to be open. One is to define a method of visual photometric comparison, and all the conditions under which it is made, in such a way that the addition law is obeyed and the results are in agreement with the curve for V_λ. The other is to define a more or less arbitrary curve of V_λ and to use a physical photometer so constructed as to give measurements in accordance with this curve. J. W. T. W.

***1179. Photometric Integrators for Mixing Radiation. P. Moon and D. P. Severance.** *J.O.S.A.* 29. *pp.* 20–25, *Jan.*, 1939.—Small photometric integrators, usually spheres, are after employed in photoelectric photometry to mix the radiation from two sources of light. The authors have examined, by empirical methods, the performance of integrators of various shapes and sizes and have studied the effect of photo-cell position. They find that, to a first approximation, the theory of the sphere may be applied also the cube, the hemisphere and the cylinder. The most convenient form is frequently the cube of, say, 10 to 15 cm. side. The cell should be placed with its sensitive surface inside the cube but so oriented that no direct radiation falls on it. It should be placed symmetrically with respect to the two entrance windows. Under good conditions, and using a white coating of high reflection factor (MgO) the photo-cell current will be as much as 10% of its value when no integrator is used. J. W. T. W.

***1180. Simple Photox Photometer Head. E. D. Wilson.** *J.O.S.A.* 29. *pp.* 35–36, *Jan.*, 1939.—A null-reading photometer head is described which employs a Photox cell integrally mounted with a graphite-graphite commutator in such mannner that the d.c. in an external instrument is

reversed synchronously with the exposure of the cell to standard and unknown source. The candle power of a Mazda lamp may be read directly on a permanent scale. AUTHOR.

*1181. **Colour Temperature–Candle Power Characteristic of Tungsten Lamps. K. S. Weaver and H. E. Hussong.** *J.O.S.A.* 29. *pp.* 16–19, *Jan.*, 1939.—Tungsten lamps are now used very extensively in photographic sensitometry, and the wide range of exposures required for various materials makes necessary the accumulation of complete data on lamps of many sizes. The characteristics of all tungsten incandescent lamps are similar in form, and in this note are described the average characteristics found for twenty lamps frequently used in this work. From a study of the slope of the straight line, best representing the average candle power–colour temperature relation, it is concluded that the changes in candle power and colour temperature, resulting from a small change in voltage, should be about equally perceptible under good conditions of observation. AUTHORS.

*1182. **Microphotometer for Rapid Spectrographic Analysis. G. Hansen.** *Zeits. f. techn. Physik*, 19. 11. *pp.* 330–332, 1938.—Describes a form of microphotometer with photocell and built-in galvanometer, suitable for the rapid measurement of spectra as required in the spectrographic analysis of metals, etc. The rapidity claimed is about ten lines per minute with an accuracy of about 5 per cent. J. W. T. W.

See also Abstracts 1153, 1172, 1176, 1189, 1281, 1326 and 604B. Response of Eye to Light in Relation to Measurement of Subjective Brightness and Contrast. W. D. Wright.

POLARISATION.

1183. Krishnan's Reciprocity Law in Colloid Optics. V. S. Vrkljan. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 353–355, *Nov.*, 1938. *In German.*—Krishnan's reciprocity relationship $H_v = V_h$, where H_v is the intensity of the horizontal components of the scattered light, when the electric vector of the incident polarised light is vertical, and V_h is the intensity of the vertical components when the incident electric vector is horizontal, is investigated for the case of oblique observation directions which are not in the horizontal plane. [See Abstract 2009 (1938).] C. B. A.

1184. Depolarisation of Raman Lines and Structure of Complex Ions. H. J. Bernstein and W. H. Martin. *Roy. Soc. Canada, Trans. Sect. III.* 32. *pp.* 43–52, *May*, 1938.—A convenient method for obtaining depolarisation factors employing polarising film has been developed. Measurements agree to within $\pm$ 5%. The four bonds in the $Hg(halide)_4^{--}$ ion are not all covalencies. The two bonds between the halide ions which attach themselves to the parent mercuric halide molecule are not covalent and must be distinguished from the other bonds within the complex ion. AUTHORS.

1185. Anomalous Depolarisation of Light-Scattering in Optical Glasses. R. S. Krishnan. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 442–447, *Nov.*, 1938.—An experimental method based on photographic photometry is described for demonstrating the existence of anomalous depolarisation, *i.e.*, ρ_h less than unity, in optical glasses. Microphotometric records are reproduced which clearly show the existence of anomalous depolarisation in optical glasses. Three typical glasses are examined. The experiment

was repeated with ether as the scattering substance and a negative result was obtained showing thereby that there was no defect in the experimental technique. AUTHOR.

1186. Depolarisation of Unmodified Light Scattering in Liquids. B. D. Saxena. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 460–475, *Nov.*, 1938.—It is shown that normal liquids (C_6H_6, CS_2) give rise to a depolarisation of the unmodified scattered light which is smaller than that of the total scattering. The value for benzene is redetermined under high dispersion. Viscous liquids (phenol, benzophenone, glycerin) give smaller differences between the depolarisations of unmodified and total scattering. The depolarisation of unmodified scattering decreases with rising temperature, and the divergences are greatest at high temperatures. C. B. A.

See also Abstracts 919, 924, 1163, 1261.

REFLECTION, REFRACTION AND DISPERSION.

1187. Spectral Reflectivity of Rhodium. W. W. Coblentz and R. Stair. *Bureau of Standards, J. of Research*, 22. *pp.* 93–95, *Jan.*, 1939.—The u.v. and visible spectral reflectivity of Rh is described. The samples examined consisted of mirrors of Rh deposited electrolytically on plate glass and upon a highly polished surface of Cu. The reflectivity of Rh decreases rapidly with wave-length, to a low value in the u.v. In the visible spectrum the reflectivity is somewhat higher than for Cr, and hence Rh is more efficient as a reflecting surface. AUTHORS.

1188. Measurement of Focal Length. K. Giesebart. *ATM No.* 90. *V*44–8, *Dec.*, 1938.—The author develops the theory of the Schultz method for determining long focal lengths with the aid of two auxiliary mirrors which reflect the light a number of times backwards and forwards through the lens. The errors introduced by slight curvatures of the auxiliary mirrors and the limitations to the method set by light losses in the lens and mirrors are examined. W. S. S.

***1189. Optical Instruments and the Theory of Optics. L. C. Martin.** *Phys. Soc., Reports*, 5. *pp.* 182–185, 1938.

1190. Optical Image Formation. F. Jentzsch. *Zeits. f. techn. Physik*, 19. 11. *pp.* 338–343, 1938. *Phys. Zeits.* 39. *pp.* 928–932, *Dec.* 15, 1938.—Abbé's experiments on image formation in the microscope have been repeated. It is maintained that the experiments do not establish that image formation is fundamentally different for self-luminous and non-self-luminous objects nor that it is different in the microscope and in other optical systems. On the other hand, Abbé's conclusions on the effects of wave-length and aperture and on the part played by the diffraction pattern in the back focal plane of the objective, can be deduced from the experiments. W. S. S.

***1191. Rapid Testing of Photographic Objectives. W. Ströble.** *Zeits. f. techn. Physik*, 19. 11. *pp.* 332–336, 1938.—Describes a method of test for definition which is so rapid that it can be applied to every lens from a factory. It is a modification of the test-star method, a series of test objects being used in turn and the results plotted on a simple diagram. Reflections and stray light are tested by means of a special test-object described and illustrated in the paper. J. W. T. W.

1192. Thin Lens System. S. Maruyama. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 967–976, *Dec.*, 1938. *In English.*—An entirely mathematical paper dealing with Seidel sums, aberrations, etc., for a thin system of lenses. A. H.

***1193. Design and Construction of the Schmidt Correction Plate for Coma-Free Mirror Systems. H. Slevogt.** *Zeits. f. Instrumentenk.* 58. *pp.* 493–495, *Dec.*, 1938.—The author determines the form of a weak plano-convex lens which when placed at the centre of curvature of a spherical mirror eliminates the spherical aberration of the system. The construction of the device from a pressure-bowed plane parallel glass plate is discussed. W. S. S.

***1194. Lithium Fluoride-Quartz Achromatic Lenses. D. C. Stockbarger and C. H. Cartwright.** *J.O.S.A.* 29. *pp.* 29–31, *Jan.*, 1939.—It is shown that the optical constants of LiF combine favourably with those of crystal quartz to form an achromatic lens covering a broad spectral range. A description is given of an air-separated doublet, of *f* 10, corrected for spherical aberration and approximately achromatic from 1800 Å to 14000 Å. A. H.

1195. Refractive Index and Molecular Refraction of CH_4 and CD_4. O. E. Frivold, O. Hassel and E. Hetland. *Phys. Zeits.* 40. *pp.* 29–32, *Jan.* 1, 1939.—Previous work [see Abstract 2445 (1938)] is extended to CH_4 and CD_4. Values of n_0 and R are given for 6 wavelengths from 4046·6 to 6562·9 Å. There is a slight indication of divergence of the dispersion curves of the two substances in the direction of decreasing wavelength. L. A. W.

1196. Reciprocal Lattice and Surfaces of Dispersion. J. Weigle. *Arch. des Sciences*, 20. *pp.* 164–202, *July–Aug.*, 1938.—A general treatment of the reciprocal lattice and surfaces of dispersion is given and the ideas introduced make possible a simple representation of the laws of refraction and total reflection in a homogeneous medium. A fairly complete analysis of the phenomena of diffraction by a periodic medium is set forth and finally a number of examples, such as deviations from Bragg's law and two-dimensional gratings, indicating the scope of the method are outlined. A. G. Q.

1197. Dispersion Theory. P. P. Ewald. *Phys. Rev.* 54. *pp.* 893–894, *Dec.* 1, 1938.—A discussion of the fundamental difficulties still to be overcome before a wave-mechanical theory of optical wave propagation can be developed to a sufficient degree of accuracy to permit of safe numerical calculation of the optical properties of crystals. A. H.

***1198. Improved Liquid-Filled Prism. F. J. Hargreaves.** *Roy. Astron. Soc., M.N.* 99. *pp.* 127–131, *Dec.*, 1938.—The paper describes a hollow liquid-filled prism of about 3¾ in. effective aperture consisting of a brass cell and two glass plates joined at their edges to the cell by flexible connections incapable of setting up stresses in the plates, which are held against rigid stops or abutments by the hydrostatic pressure of the dispersing liquid in the prism. AUTHOR.

1199. Recent Developments in Optical Glass Manufacture. W. M. Hampton and W. N. Wheat. *Phys. Soc., Reports*, 5. *pp.* 185–190, 1938.

1200. Crystalline Silica in Devitrified Glasses. A. Q. Tool and H. Insley. *Bureau of Standards, J. of Research*, 21. *pp.* 743–772, *Dec.*, 1938.—A series of tests on devitrifying glass was made by heating to temperatures from 625° to 950° C. Heating and cooling curves were made and the specimens examined microscopically and by X-rays. The apparent inversion points of cristobalite ranged from 201° to 218° on heating and 192° to 240° on cooling. The corresponding ranges for tridymite were 145° to 164° and from 127° to 155°, while the corresponding

points for quartz fell between 570° and 576° The significance of the results is discussed. [See following Abstract.] F. S.

1201. Expansion Effects on Inversion in Devitrified Glasses. A. Q. Tool and J. B. Saunders. *Bureau of Standards, J. of Research,* 21. *pp.* 773–778, *Dec.*, 1938.—Expansion curves are given for the glasses previously discussed [see preceding Abstract], the results being found to agree with those reported there. F. S.

***1202. New Non-Electrical Instruments. R. S. Clay.** *Journ. Sci. Instruments,* 16. *pp.* 47–53, *Feb.*, 1939.—A review of some new non-electrical instruments shown at the Physical Society's Exhibition of 1939.

See also Abstracts 924, 927, 938, 1003, 1011, 1255.

SPECTROSCOPY.

***1203. Controlled Spark as Light Source for Spectrum Analysis. H. Kaiser.** *Zeits. f. techn. Physik,* 19. 11. *pp.* 399–402, 1938.—In Feussner's method for obtaining a train of sparks of identical character a rotating interrupter worked by a synchronous motor is placed in series with the spark gap and the condenser. Each time the circuit is made by the interrupter a spark passes which is in fact a high frequency oscillation. By suitable choice of the electric constants of the spark circuit this oscillation is damped out by the time the circuit is broken so that the condenser is charged up always to the same voltage when the spark passes. The uniformity in the sparks obtained by this method is shown by photographs in a rotating mirror. The method is applied specially in quantitative spectrum analysis. W. S. S.

1204. Strontium Lines in Arc and Solar Spectra. F. J. Sullivan. *Univ. of Pittsburgh, Bull.* 35. *pp.* 284–291, *Oct.* 1, 1938.—Data for 121 lines are reported. W. R. A.

1205. Analysis and Interpretation of Spectra of Neodymium Salts. H. Ewald. *Ann. d. Physik,* 34. 3. *pp.* 209–236, *Feb.*, 1939.—The absorption spectrum of $Nd^{\cdots}$ ions has been investigated in various compounds :—$Zn_3Nd_2(NO_3)_{12}.24H_2O$; $Mg_3Nd_2(NO_3)_{12}.24H_2O$; $Nd(NO_3)_3.6H_2O$; $Nd_2(SO_4)_3.8H_2O$; $Nd(BrO_3)_3.9H_2O$; and $NdCl_3.6H_2O$. Three different types of lines are observed : (i) groups of intense lines, the intensity of which increases with the thinness of the absorbing layers, (ii) well-defined weak lines which become more intense with thicker absorbing layers, and (iii) diffuse weak lines. (ii), which appear between (i), show in their positions a repetition of (i) on the short wave side ; whilst (iii) are found at approximately 100 cm^{-1}. on the short wave side of (i). (i) are interpreted as simple electronic transitions ; (ii) as combinations of the electronic transitions of the $Nd^{\cdots}$ ions and the eigenfrequencies of the crystal water ; and (iii) as combinations of the electronic transitions and the lattice vibration frequencies. The sensitivity of the different lines towards isomorphous replacement of individual crystal lattice constituents is discussed. W. R. A.

1206. Width and Displacement of Spectral Lines of Hg in High Pressure Discharge. P. Schulz. *Zeits. f. techn. Physik,* 19. 12. *pp.* 585–588, 1938.—Distinction is made between symmetrical collision broadening of lines and unsymmetrical statistical broadening [see Abstract 2885 (1938)]. Broadening of the 2^1P_1 term of Hg in the high pressure discharge is due to collisions with similar atoms, broadening of 3D terms is due to collisions with electrons. At 80 atm. the width of 2^1P_1 is less than is expected theoretically, the width of 3D terms, however, is in

accord with theory. Statistical broadening is significant for triplet lines, the unsymmetry increases with pressure. Line displacements are small and in most cases towards the red ; only terms with large collision widths give larger displacements which are towards the violet. J. E. K.

1207. Radiation of Wave-Length 2537 Å in the Low Pressure Hg Discharge. F. Rössler and F. Schönherr. *Zeits. f. techn. Physik*, 19. 12. *pp.* 588–592, 1938.—The energy radiated in Hg 2537 Å from a low pressure discharge in pure Hg vapour and from a mixture of Hg and Ne is measured for various pressures and currents. In the most favourable conditions 60% of the electrical energy is radiated in this line. From the discharge with admixed Ne the radiation efficiency decreases with increasing current and increasing pressure ; from the discharge through pure Hg vapour the radiation efficiency increases as the pressure is increased from low values and passes through a sharp maximum efficiency which is biggest for the smallest values of the current. A satisfactory theoretical explanation of the different characteristics of the two types of discharge is given. Reasons are advanced for the comparative weakness of the emission of the singulet Hg resonance line 1850 Å. J. E. K.

1208. Fine Structure of Line λ4686 of Ionised Helium. Djen-Yuen Chu. *Phys. Rev.* 55. *pp.* 175–180, *Jan.* 15, 1939.—The fine structure of the line λ4686 of ionised He emitted from a discharge tube with hollow kathode cooled by liquid air was measured with a Fabry-Perot interferometer. The formula for the pattern obtained with this instrument expressed in Fourier series was applied in the analysis. Of the eight components predicted by theory, four were definitely observed, while the remaining weak ones were inferred from the pattern to be present. Relative intensities and positions of the eight components were found to be in general agreement with theory. The separation between the two strongest components was $0{\cdot}0095 \pm 0{\cdot}0024$ IÅ or $0{\cdot}4529 \pm 0{\cdot}0109$ cm^{-1}. The Rydberg constant for He was calculated to be $109{,}722{\cdot}430 \pm 0{\cdot}030$. AUTHOR.

1209. Atomic Spectra. A. G. Shenstone. *Phys. Soc., Reports*, 5. *pp.* 210–227, 1938.

1210. Hyperfine Structure. M. F. Crawford. *Phys. Soc., Reports*, 5. *pp.* 227–233, 1938.

1211. Hyperfine Structure of Gold. R. M. Elliott and J. Wulff. *Phys. Rev.* 55. *pp.* 170–175, *Jan.* 15, 1939.—The spectrum of Au I and Au II has been examined for hyperfine structure in the region 2300–6300 Å. Splitting has been observed in more than eight lines of the spectrum of Au I, whereas the hyperfine structure of Au II lines could not be resolved. From the four-component structure of the lines 4437 and 4607 Å it is shown that the mechanical moment of the gold nucleus is $(3/2)(h/2\pi)$. The effect of self-reversal in the resonance lines has been investigated and eliminated. The magnetic moment determined from the splitting of the unreversed resonance line 2428 Å is found to be 0·195 proton-magneton. No other determination of the magnetic moment is at present possible because of the intermediate coupling shown to exist in the complex electronic configurations of Au I and the inadequacies of the present theory of hyperfine structure. The splitting of the $^2P_{1/2}$ level is estimated and found to be in approximate agreement with that calculated from the $^2S_{1/2}$ level. No indication of any abnormally large $^2P_{1/2}$ separation or of any isotope shift has been found. AUTHORS.

1212. Hyperfine Structure of Mn I and Nuclear Magnetic Moment. R. A. Fisher and E. R. Peck. *Phys. Rev.* 55. *pp.* 270–276, *Feb.* 1, 1939.—New measurements of the structure of the green lines of Mn I combined with the data already available make possible a determination of 24 hyperfine interval factors. Interval factor formulæ derived by the method of energy sums are in reasonable accord with much of the data. This permits an approximate determination of the nuclear magnetic moment of Mn^{55}, which is found to be 3·0 nuclear magnetons. AUTHORS.

***1213. Infra-Red Absorption Spectra of Aliphatic and Homocyclic Hydrocarbons. Part II. P. Lambert and J. Lecomte.** *Ann. de Physique*, 10. *pp.* 503–583, *Dec.*, 1938.—With a new infra-red spectrometer, which is described, and another previously described [see Abstract 1052 (1938)], the absorption of about 50 hydrocarbons in the region 7 to 20μ have been examined. They comprise saturated and unsaturated aliphatic hydrocarbons and homocyclic hydrocarbons (substituted benzene hydrocarbons of two benzene nuclei with a nucleus of five C atoms). The positions of the absorption maxima are directly related with the chemical structure of the compounds, in agreement with previous work, and thus indicate the use of infra-red absorption spectra as a method of identification. The data obtained are interpreted by the theory of molecular vibrations. W. R. A.

1214. Infra-Red Spectrum and Molecular Constants of Carbon Monoxide. S. E. Whitcomb and L. T. Lagemann. *Phys. Rev.* 55. *pp.* 181–183, *Jan.* 15, 1939.—The fundamental and first overtone bands of CO have been measured under high resolution and the lines in the positive and negative branches in both bands have been fitted to formulæ of the form $\nu = a + bm + cm^2 + dm^3$. The molecular constants ν_0, I_0, B and C as defined by Colby depend directly on the constants a, b, c, d and have been determined from these measurements. Their values are $\nu_0 = 2168{\cdot}48$ cm^{-1}., $I_0 = 1{\cdot}429 \times 10^{-39}$ gm. cm^2., $B = 1{\cdot}38 \times 10^{-6}$, $C = 6{\cdot}202$. The constants used in electronic work, as defined by Jevons, have also been computed and are in close agreement with previous results. AUTHORS.

1215. Spectroscopic Comparison of the Proton-Attracting Properties of Liquids. W. Gordy. *J. Chem. Phys.* 7. *pp.* 93–99, *Feb.*, 1939.—The use of isotopic hydrogen has made possible an extension of the study of hydrogen bonds between unlike molecules to include many new types of donor solvents. From the magnitude of the shifts which the different solvents produce in the OD fundamental band of CH_3OD, a comparison of the proton-attracting properties of the different solvents can be made. It is suggested that this method may be used as a practical means of comparing the intrinsic strength of organic bases. Solvents representative of the classes—nitro-compounds, esters, aldehydes, ketones, ethers, nitriles and amines—were employed, and the results give proof of the wide occurrence of hydrogen bonding between unlike molecules. [See Abstract 709 (1938) and following Abstract.] AUTHOR.

1216. Infra-Red Absorption of HCl in Solution. W. Gordy and P. C. Martin. *J. Chem. Phys.* 7. *pp.* 99–102, *Feb.*, 1939.—The fundamental HCl vibrational band has been observed for solutions of HCl in nitrobenzene, *o*-nitrotoluene, ethyl acetate, di-ethyl ether, isopropyl ether, *n*-butyl ether, and dioxan. The band is shifted appreciably to lower frequencies in all of these solvents. The shifts are too great to be attributed wholly to the dielectric constants of the solvents; they are in-

terpreted as being caused primarily by hydrogen bonding between the HCl and the solvent. [See preceding Abstract.] AUTHORS.

1217. Assignment of Electronic Bands in Spectra of Solutions. Part I. G. Kortüm. *Zeits. f. phys. Chem.* 42. *Abt.B.* 1. *pp.* 39–66, 1939.—The absorption spectra of dissolved aromatic nitro-compounds have been measured in the visible and the u.v. regions. Water as well as acids and alkalis have been used as solvents. The author discusses the results in the light of the recent quantum-theoretical conceptions of chemical linkages and shows the relation between absorption and chemical constitution. L. K.

1218. Spectra of Alkali-Metal Hydrides. R. W. B. Pearse. *Phys. Soc., Reports*, 5. *pp.* 249–256, 1938.

1219. Absorption Spectra and Structure of Rhodamines. P. Ramart-Lucas. *Comptes Rendus*, 207. *pp.* 1416–1418, *Dec.* 27, 1938.—Absorption spectra of both base and salts are recorded for a number of rhodamines in various solvents. Structural formulæ are deduced for the bases, and for their coloured and uncoloured hydrated forms. C. B. A.

1220. Absorption Spectra of Benzoylformyloxindole Phenylhydrazone and Derivatives. F. W. Bergstrom and R. Robinson. *Chem. Soc., J. pp.* 189–195, *Jan.*, 1939.—The absorption spectra of solutions of arylhydrazones of benzoylformyloxindole have been examined in the hope of finding an explanation of the changes of visible colour observed in different solvents. AUTHORS.

1221. Spectrum of Mono-Deuteromethane in the Photographic Infra-Red. Part I. W. H. J. Childs and H. A. Jahn. *Roy. Soc. Proc.* 169*A*. *pp.* 428–437, *Feb.* 7, 1939.—The preparation of 40 l. of CH_3D is described. The purity of the gas was tested by density measurements and by the complete absence of even the strongest absorption lines of CH_4 on the photographic plates obtained. The absorption spectrum of the gas has been investigated from 8400 to 13000 cm^{-1}. in the photographic infra-red, and measurements are given of a particularly simple band at 9021 cm^{-1}. From this band the moment of inertia of the molecule perpendicular to the C-D axis can be deduced and a value of $7{\cdot}202 \times 10^{-40}$ gm. cm^2. is obtained. This corresponds (assuming a regular tetrahedral structure) to a C-H distance of 1·093 Å, to be compared with 1·092 Å. in the case of CH_4. The band is assigned tentatively as the parallel component of $3\nu_2$, the second overtone of the perpendicular fundamental at 3031 cm^{-1}. AUTHORS.

1222. Se_2 Spectrum. B. Rosen. *Physica*, 6. *pp.* 205–218, *Feb.*, 1939. *In French.*—The absorption, emission and resonance spectra of Se_2 are reinvestigated. Some contradictions existing between the statements of different authors are removed. The main system (probably $(^3\Sigma - {}^3\Sigma)$ may be represented by $\nu = 26035 - 391{\cdot}77\,u'' + 1{\cdot}06\,u''^2 - 0{\cdot}002\,u''^3 + 281{\cdot}11\,u' - 2{\cdot}65\,u'^2$. All the bands of selenium observed in emission and in absorption between 2800 and 5200 Å belong to this main system. Isotopic effect and perturbations in the upper level of the main system are investigated. Abnormal isotopic effects are observed for the perturbed levels. Several questions regarding other band systems attributed to selenium (in particular the fluting bands in the visible) are discussed. AUTHOR.

1223. Force Constants, Internuclear Distance and Dissociation Energy of Diatomic Linkage. G. B. B. M. Sutherland. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 341–344, *Nov.*, 1938.—Various empirical formulæ,

starting with the Morse relation $\omega_e R_e^3 =$ constant, are examined and quantum mechanics applied with a view to finding a theoretical basis for the relations. Some suggestive and interesting results are obtained. A. H.

1224. Vibrations of Selected Molecular Models. O. Burkard. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 365–382, *Nov.*, 1938. *In German.*—Frequency, mode of vibration, and energy distribution are calculated for the plane vibrations in terms of the model constants in the following cases: 1 : 3 : 5 — substituted benzene, C_6X_3; tetra-substituted ethylene, $X_2C = CX_2$; *cis*- and *trans*-substituted ethylene, X — C = C — X; and the phosgene type, X — CO — X. C. B. A.

1225. Proper Vibrations of Mechanical Molecular Models. F. Trenkler. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 383–392, *Nov.*, 1938.—In continuing previous work [see Abstract 2748 (1936)] modes of vibration and proper frequencies are experimentally determined for models of cyclobutane, cyclobutene, cyclobutadiene, cyclobutanone and cyclobutane-1-3-dione. The agreement with the theoretically calculated values is in general satisfactory. Large discrepancies are found, however, in the case of vibrational modes involving pure deformation of rings with even numbers of members. These are quantitatively explained as due to a mechanical property of the model. The effect of the occurrence of rotational vibrations of individual masses is discussed. L. A. W.

1226. Intensities of Electronic Transitions in Molecular Spectra. Parts I and II. R. S. Mulliken. *J. Chem. Phys.* 7. *pp.* 14–33, *Jan.*, 1939.—In Part I the neglected problem of the theory of the absolute intensities of electronic transfers in molecular spectra is discussed. General equations for dipole strength, Einstein coefficients, mean lifetimes of excited states, etc., are set out in convenient form. In Part II are discussed two related types of high intensity molecular spectra, charge-resonance spectra and charge-transfer spectra, both types usually involving transfer of one electron from a bonding to the corresponding antibonding molecular orbital. In the atomic orbital approximation the first type involve a transition from a symmetrical to a corresponding antisymmetrical state, the second type involves a transition from a state having a nonionic to one having an ionic wave function. Theoretical equations for dipole strengths and f values for both these types are given in each case calculated according to each of the two approximations. The equations are very simple, the dipole strength being proportional to the distance across which the charge resonates or is transferred. Examples of the two types of spectra are discussed and although experimental data are scanty they appear to be in harmony with the theory. A. H.

1227. Interaction between Rotation and Oscillation in Deutero-Formaldehyde. H. H. Nielsen. *Phys. Rev.* 55. *pp.* 289–293, *Feb.* 1, 1939.—The unsymmetrical broadening of the Q branch toward higher frequencies in the parallel type bands near 1100 cm^{-1}. in the absorption spectrum of deutero-formaldehyde is taken as a manifestation of convergence toward lower frequencies rather than, as is usual, in the case of infra-red bands, toward higher frequencies. This phenomenon is accounted for by taking into account an intereaction between rotation and oscillation of the Coriolis type arising from the accidental degeneracy of the three vibration frequencies, belonging to three different symmetry classes, falling near 900 cm^{-1}., 1000 cm^{-1}. and 1100 cm^{-1}. AUTHOR.

1228. Continuous Spectra of H_2 and D_2. H. M. James and A. S. Coolidge. *Phys. Rev.* 55. *pp.* 184–190, *Jan.* 15, 1939.—A complete

theoretical calculation has been made of the continuous spectra H_2 and D_2 arising from transitions from the lower vibrational levels of the $1s\sigma 2s\sigma^3\Sigma_g$ state to the unstable $1s\sigma 2p\sigma^3\Sigma_u$ state. Use of the Franck-Condon approximation has been avoided by a direct computation of the electric moment of the electronic transition, as a function of nuclear separation; this quantity is found to decrease rapidly with increasing nuclear separation. Spectra are computed for transitions from each of the vibrational levels separately, and absolute mean lives are determined for the various levels. Relative probabilities of excitation from the ground state of the molecule by electron impact are estimated, and the intensity in the spectrum due to excitation by electron impact is computed for a range of energies of the electrons. The Franck-Condon approximation is found to be more satisfactory than was indicated by a previous investigation. There is sharp disagreement of the results with the observations of Smith. This apparently arises from errors in Smith's intensity standard, and emphasises the need for a more satisfactory u.v. intensity standard. Agreement with the results of Finkelnberg and Weizel is obtained, but its significance is weakened by uncertainties in the experimental conditions. [See Abstracts 1687 (1936) and 4939 (1938).] AUTHORS.

1229. Absorption Spectra of ZnS and ZnS-CdS Phosphors. J. H. Gisolf. *Physica*, 6. *pp.* 84–96, *Jan.*, 1939. *In English.*—The absorption spectra of ZnS and ZnS-CdS activated with Cu, Mn and Ag have been studied by a new method. All show a similar spectrum—an absorption rising gradually towards the u.v., with a sudden rise at a definite wave-length to a very large value. This critical wave-length is independent of the crystal structure for ZnS, and of the activator in the case of Cu and Ag, and is therefore taken as characteristic of the ground material. It lies at about 3350 Å. With the mixed sulphides the critical wave-length moves towards the long waves with increasing Cd content. The ZnS-Mn absorption shows a complicated behaviour. The fundamental absorption gives rise to a luminescence which is characteristic of the activator. The absorption limit marks in the excitation spectrum a sharp division between a region of long-duration excitation and a region of short-duration excitation. The long-wave limit of photoconductivity excitation coincides with the short-wave limit of absorption and with the long-wave limit of photochemical blackening. J. E.

1230. Stark Effect and Related Phenomena. J. S. Foster *Phys. Soc., Reports*, 5. *pp.* 233–241, 1938.

1231. Relation between Enhancement and Weakening of Series by an Electric Field. R. Ritschl and R. Siksna. *Zeits. f. techn. Physik*, 19. 12. *pp.* 584–585, 1938.—Photographical photometric measurements of line emission intensities from a He canal ray show that concurrently with the appearance of forbidden transitions in the electric field there occurs a weakening of the allowed transitions from the same higher level. The intensities of forbidden lines increase at first roughly quadratically with field strength but the increase becomes less rapid towards higher fields and shows an indication of passing through a maximum somewhat above 150 KV/cm. J. E. K.

1232. Stark Effects in the Na Arc Spectrum. W. Olbers. *Ann. d. Physik*, 33. 8. *pp.* 708–722, *Dec.*, 1938.—The Stark effects of several S, P and D terms of Na are observed in fields up to 50 kV cm^{-1}. The 6P to 8P terms show a quadratic effect which, in accord with theory, increases as

the 7th power of the effective principal quantum number. A discrepancy between the observed trend of the Stark effect and the trend noted by Bartels in observations of the arc plasma indicates that the results obtained in observations of the Stark effect in a directed field cannot be applied to the case of the undirected arc plasma field. The 5S to 8S terms exhibit a similar quadratic effect dependent on N^7_{eff}. The 5D and 6D terms show a quadratic effect up to field strengths of 20 and 10 kV/cm. respectively and a transition to a linear effect for higher field strengths. The results are compared with Unsold's theory and with the measurements of other investigators. J. E. K.

1233. Raman Effect and Constitution of HNO_3 and $HNO_3 \cdot H_2O$. A. Simon and H. Höppner. *Kolloid Zeits.* 85. *pp.* 8–15, *Oct.*, 1938.—Raman spectra are obtained for 100% HNO_3 and its monohydrate in the liquid and crystalline forms. The spectra of the two substances in the liquid form are so similar that the possibility of the existence of an ortho-acid in the liquid form may be excluded. In the crystalline form the two substances again have very similar Raman spectra, but of a different type from that of the liquids. The results support the view that on crystallisation the pseudo-forms $NO_2 \cdot OH$ and $NO_2 \cdot OH \cdot H_2O$ are transformed into the aci-forms $[H][NO_3]$ and $[H \cdot H_2O][NO_3]$. There is no evidence of the existence of an ortho-acid in the crystalline form. L. A. W.

1234. Statistical Analysis of Trends in Research on Raman Effect. J. H. Hibben. *Indian Acad. Sci., Proc.* 8*A. pp.* 294–300, *Nov.*, 1938.—There are outlined in this presentation, the trends, during a ten-year period, in interest in the Raman effect as a function of time and geographical distribution. The interest in particular types of organic and inorganic compounds is evaluated, and the reasons for preferential treatment of certain classes and compounds are discussed briefly. AUTHOR.

1235. Raman Spectra of Volatile Fluorides. D. M. Yost. *Indian Acad. Sci., Proc.* 8*A. pp.* 333–340, *Nov.*, 1938.—Discusses the applications of Raman spectra to chemical problems in the case of a number of comparatively simple molecules. A. H.

1236. Interpretation of Raman Spectra in Crystals: Anhydrite and Gypsum. S. Bhagavantam. *Indian Acad. Sci., Proc.* 8*A. pp.* 345–348, *Nov.*, 1938.—Application of group theory to a study of the normal oscillations of the crystal lattices of anhydrite and gypsum shows that the degenerate modes of the free SO_4 ion would be expected to split up completely in the crystal. All the split components are Raman active. The experimental results obtained with anhydrite are in entire agreement with this view. The case of gypsum also gives results which are in general agreement with the theory. The splitting is a consequence of the lower symmetry of the crystals as a whole and need not be taken as indicating a lack of tetrahedral symmetry for the SO_4 ions individually. AUTHOR.

1237. Normal Frequency of Diamond Lattice. T. Venkatarayudu. *Indian Acad. Sci., Proc.* 8*A. pp.* 349–352, *Nov.*, 1938.—The diamond lattice has only one limiting normal mode of oscillation. In this mode the two interpenetrating lattices oscillate against each other, the direction of oscillation being arbitrary. The corresponding frequency is active in the Raman effect and inactive in infra-red absorption. The fact that only one Raman line possessing a very large intensity is obtained is in agreement with the above results. The weaker lines and also the infra-red absorption maxima are to be regarded as secondary effects. AUTHOR.

1238. Raman Spectrum and Structure of PCl_5. H. Moureu, M. Magat and G. Wetroff. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 356–364, *Nov.*, 1938. *In French.*—The Raman spectrum of PCl_5 is measured as solid, liquid and vapour, and in solution in PCl_3 and in CCl_4. The spectra of the liquid and solid forms differ, and are superposed at the melting point. The CCl_4 solution gives the liquid type of spectrum ; the solution in PCl_3 gives the mixed spectrum. The existence of two forms of PCl_5, with a transition at the melting point, is indicated, in agreement with its chemical behaviour, and the liquid form consists of a bipyramid on a trigonal base with the P atom at the centre. The structure of the solid is less clear, but its spectrum is similar to those of liquid $SbCl_5$ and of solid $NbCl_5$. A tetrahedron of PCl_4 with the fifth Cl atom outside and attached by a polar bond, $\overset{+}{PCl_4}\overset{-}{Cl}$, is suggested ; but these structures cannot be reconciled with the observed dipole moments without further assumptions. C. B. A.

1239. Scattering of Light in Sodium Nitrate Crystals. Part I. T. M. K. Nadungadi. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 397–404, *Nov.*, 1938.—A detailed study of the Raman spectrum of $NaNO_3$ at a series of temperatures ranging from 25° C. to 290° C. has been carried out with fairly large single crystals prepared from melts of the substance. The investigation has also been extended to the case of the substance in the molten state. The most interesting effect noticed is the simultaneous broadening and shifting towards the exciting radiation of the lines due to lattice oscillations with rising temperature. The symmetrical oscillation of the nitrate ion shows a shift of 4 wave numbers at 290° C. The 1385 line broadens out considerably as compared with the 720 line. The spectrum of the molten substance shows an intense wing accompanying the Rayleigh line similar to those exhibited by aromatic liquids. The 1385 line observed in the crystal becomes a broad band extending over 160 wave numbers in the molten substance. AUTHOR.

1240. Raman Spectra of Paraffin Hydrocarbons. G. B. Bonino and R. Manzoni-Ansidei. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 405–418, *Nov.*, 1938. *In Italian.*—The Raman spectra of hexane, heptane, octane and 13 aliphatic compounds of these hydrocarbons in which the methyl group is linked to the paraffin in side chains are tabulated. It is shown that there are distinct differences in the Raman spectra of hydrocarbons with side chains and without them. These differences affect mainly the regions 600–800 cm^{-1}. and 900–1000 cm^{-1}. It follows from the experiments that the presence of intense lines at approximately 820 cm^{-1}. and between 900 and 1000 cm^{-1}. is characteristic for hydrocarbons containing side chains. L. K.

1241. Chart of Raman Bands of Water in Crystals. P. G. N. Nayar. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 419–423, *Nov.*, 1938.—A study of the Raman bands due to water of crystallisation in 16 different substances has been made, and the results are presented in the form of a chart [see Abstract 3613 (1937)] along with the earlier data available from the work of Ananthakrishnan. AUTHOR.

1242. Low Frequency Raman Lines in Organic Crystals. C. S. Venkateswaran. *Indian Acad. Sci., Proc.* 8*A*. *pp.* 448–459, *Nov.*, 1938.—The Raman spectra of the low frequency region between 20 and 130 cm^{-1}. have been recorded for 14 organic solids and the influence of rise of temperature up to the melting point on these lines in a few cases has been investigated. These lines in the solids are interpreted as arising

partly from translational and partly from rotational oscillations of the molecules with definite phase-relationship with each other in the lattice. Liquid salol exhibits a fairly intense wing near the Rayleigh line which does not appear in salol glass at liquid-air temperature. This observation and other experimental facts such as extension of the wing, the distribution of intensity and the influence of temperature on it and the degree of depolarisation at different points in the wing and the corresponding lines in the solid do not support the hypothesis of Gross and Vuks that most of the wing in liquids arises from the lattice Raman lines and that the liquid state is quasi-crystalline in structure. A band observed in liquids, benzophenone, diphenyl ether and diphenyl in the place of a line above 100 cm^{-1}. in the solids is attributed to a deformational oscillation in the molecule itself, which seems to be characteristic of bicyclic compounds. AUTHOR.

1243. Raman Effect and Multiple Scattering of Light. A. Kastler. *Indian Acad. Sci., Proc.* 8*A. pp.* 476–482, *Nov.*, 1938.—The frequency distribution of scattered photons after several successive Raman scatterings is investigated. After m such processes, light of frequency N becomes distributed over m different frequencies which form an arithmetical progression from N to N–mn, n being the displacement at each scattering. As m increases, the proportion of unchanged photons decreases in geometrical progression, and the proportion of modified photons becomes increasingly important. In quartz, four successive scatterings are sufficient to render the Raman line as important as the Rayleigh line, and 30% of the quaternary scattering then belongs to the lines of frequency N–2n and upwards. C. B. A.

1244. Raman Spectra of Terpenes. W. R. Angus. *Indian Acad. Sci., Proc.* 8*A. pp.* 529–565, *Nov.*, 1938.—The available Raman spectral data on terpenic compounds are tabulated and reviewed. It is concluded that the identification of the constituents of a mixture of terpenes by Raman effect methods cannot give trustworthy results until confirmatory results on possible constituents have been obtained. AUTHOR.

1245. Further Application of New Method of Analysis to Raman Spectra. H. Deslandres. *Comptes Rendus*, 207. *pp.* 1341–1346, *Dec.* 27, 1938.—The new method of analysis [see Abstract 727 (1939)] has been applied to the Raman spectra of $CHCl_3$ and NH_4Cl. Of the two possible arrangements $CHCl–Cl_2$ and $ClH–CCl_2$, the second is predominant in liquid $CHCl_3$. In NH_4Cl crystals the arrangement $ClH–NH_3$ is predominant. The complexes $K_4Fe(CN)_6.3H_2O$, $K_3Cu(CN)_4$, and $KAg(CN)_2$ have also been considered. W. R. A.

1246. Raman Spectra of Cis- and Trans-α- and β-Decalones. D. Biquard. *Comptes Rendus*, 207. *pp.* 1415–1416, *Dec.* 27, 1938.—The following values, in cm^{-1}., are deduced from Raman spectrum measurements for the frequency of the C = O bond :—From *cis*-α-decalone, 1708 ; *trans*-α-decalone, 1709; *cis*-β-decalone, 1711 ; *trans*-β-decalone, 1714. C. B. A.

1247. Raman Spectrum of Nitrogen. C. E. Miller. *J. Chem. Phys.* 6. *pp.* 902–904, *Dec.*, 1938.—The Raman spectrum of N_2 under a pressure of 4 atm. has been recorded, and the relative intensities of the rotational lines have been compared with those to be expected from the formula of Placzek and Teller. The agreement is good. A. C. M.

1248. Raman Spectra Associated with the Ethylene Bond. C. Prévost. *Comptes Rendus*, 208. *pp.* 39–40, *Jan.* 3, 1939.—To the

ethylene linkage in a linear hydrocarbon is attributed the wave-number 1642 cm^{-1}., if it is at the end of the chain, 1658 and 1674 if not at the end of the chain, the latter belonging to the *trans* isomer. In the α-ethylene alcohols, these numbers are usually increased by 4 cm^{-1}. The wave-numbers found for the three glycols are respectively 1645·7, 1677·7, and 1682·3, and it is concluded that the two glycols as prepared were *trans* isomers. A. C. M.

1249. Raman Spectrum and Constitution of CdI_2 Solutions. M. L. Delwaulle, F. François and J. Wiemann. *Comptes Rendus*, 208. *pp.* 184–186, *Jan.* 16, 1939.—Continuing previous work [see Abstract 1221 (1938)] the authors investigate the Raman spectra of concentrated solutions of CdI_2, with and without alkali iodide, in water and normal alcohols from propanol to decanol. The degree of depolarisation of the Raman lines is measured. In the higher alcohols the persistence of one almost completely polarised line ($\Delta\nu = 142$ cm^{-1}.) is taken to indicate the presence of linear undissociated molecules CdI_2. The solutions of CdI_2 in water, alone or with alkali iodide, and the solutions in the alcohols with alkali iodide (*i.e.*, all solutions containing excess of iodide ion) show a line ($\Delta\nu = 144$ cm^{-1}.) whose degree of depolarisation is at least 0·7. This, together with three other observed lines, is ascribed to a tetrahedral complex CdI_4. L. A. W.

See also Abstracts 1054, 1129, 1182, 1184.

TRANSMISSION.

1250. Penetration of Light through Dense Fog. M. Kinoshita, K. Uchiyama and T. Nakajima. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers No.* 856. *pp.* 1681–1689, *Nov.*, 1938. *In English.*—The transmission characteristics of artificial fog are investigated spectrophotometrically, and the transmission wave-length relations found are compared with the results of theoretical calculations. A full description is given of the methods of producing the fog and of examining the light transmitted by it. The results of the microphotometrical measurements are represented graphically showing the relation between the transparency and the wave-length commencing from different values of the transparency at 6500 Å. The figures show that the transparency of this artificial fog increases rapidly with decreasing wave-length. The droplet size of the artificial fog, however, corresponds to that of the finest natural fog, and so if the size of droplet be increased the fog will be practically neutral. The effect of particles other than water droplets is also discussed and in addition that of conducting fog particles. A. E. M. G.

See also Abstract 1073.

VISION.

1251. Theory of the Light Sense. A. Kühl. *Zeits. f. Instrumentenk.* 58. *pp.* 469–492, *Dec.*, 1938.—The theory leads to a numerical specification of the subjective brightness of a light patch of given physical brightness and of given size as seen by a normal eye adapted to a given physical brightness (which is in general different from that of the light patch). In a graph with the patch brightness and the adapting brightness as axes, a family of curves of equal subjective brightness is determined for each patch size. The curves are derived from measurements of the

threshold brightness and the blinding brightness at different adapting brightnesses. The theory is applied to determine the variation of visual acuity with brightness and the limits of visibility of stars by day and by night. W. S. S.

1252. Trichromatic Theory of Colour Vision. W. Peddie. *Roy. Soc. Edinburgh, Proc.* 59. 1. *pp.* 15–21, 1938–1939.—Reviews some of the early vicissitudes of the trichromatic theory and concludes that the main tenet of the theory is now an established fact. W. S. S.

1253. Duplexity Theory of Visual Response in Vertebrates. Part II. W. J. Crozier and E. Wolf. *Nat. Acad. Sci., Proc.* 24. *pp.* 538–541, *Dec.*, 1938.—Continuing previous work [see Abstract 2484 (1938)] the authors have determined the relation between critical flicker frequency F and brightness I for the gecko *Sphaerodactylus* which is a nocturnal animal with a purely rod retina. The maximum value of F attained at high brightnesses was found to be low (26·6) compared with that for other animals (47 to 63). On the other hand, the curve of F against I occupied the same position with respect to the brightness axis as the corresponding curve for the turtle *Pseudemys* which has a purely cone retina. This result appears to negative the view that a rod retina necessarily functions best at low illuminations. W. S. S.

1254. Specific Constants for Visual Excitation. Part III. W. J. Crozier and E. Wolf. *Nat. Acad. Sci., Proc.* 24. *pp.* 542–545, *Dec.*, 1938.—Further data are presented on the critical flicker-brightness curve for genetically related fresh-water teleosts. The results confirm previous conclusions. [See Abstracts 5369 (1937) and 3284 (1938).] W. S. S.

1255. Visual Acuity and Resolving Power of Optical Instruments, particularly the Human Eye. H. Schober. *Zeits. f. techn. Physik*, 19. 11. *pp.* 343–344, 1938. *Phys. Zeits.* 39. *pp.* 934–936, *Dec.* 15, 1938.—Rayleigh's criterion for resolving power, based on the relative position of the diffraction patterns of the two points to be separated, is criticised as being inconsistent with the Weber-Fechner law on the power of the eye to discriminate differences of brightness. The two viewpoints lead to different variations of visual acuity with colour of the light and experimental measurements of this variation are found to accord better with a criterion based on the Weber-Fechner law. The experiments show that Hg light gives the highest acuity, then Na light and, finally, white and red light. W. S. S.

***1256. Correcting Lenses after Cataract Operation. A. Polack.** *Comptes Rendus*, 208. *pp.* 127–128, *Jan.* 9, 1939.—It is suggested that the gradual reduction in visual acuity sometimes observed after cataract operation, is caused by the greater amount of u.v. radiation reaching the retina, this radiation having previously been absorbed by the crystalline lens. A glass is therefore described that aims at giving the same u.v. absorption as that normally produced by the eye lens. W. D. W.

1257. Fluorescence of the Crystalline Lens. Y. le Grand. *Comptes Rendus*, 207. *pp.* 1128–1135, *Dec.* 5, 1938.—A photographic method was used to measure the energy distribution in the spectrum of the fluorescent light emitted by the crystalline lens of a sheep's eye irradiated with the u.v. lines 366 and 313 mμ of the Hg lamp. From the results, the colorimetric hue (468 mμ) and purity (0·64) of the fluorescent light are computed for the standard colorimetric observer. The colour of

the light seen by a human eye irradiated with u.v. light is predicted and compared with recent observations by Gaydon. W. S. S.

See also Abstract 1189.

X-RAYS.

1258. Soft X-Ray Spectroscopy of Solid State. H. W. B. Skinner. *Phys. Soc., Reports*, 5. *pp.* 257–283, 1938.

1259. X-Ray Scattering by a System of Rotating Molecules. C. Finbak. *Phys. Zeits.* 40. *pp.* 26–28, *Jan.* 1, 1939.—An earlier theory by Debye on the scattering of X-rays by a system of electrons [see Abstract 1271 (1915)] is extended to the case of an assemblage of rotating systems. It is concluded that a crystal lattice consisting of molecules whose rotation is free and spherically symmetrical will have a different scattering power from a lattice in which the rotating molecules are replaced by " spherically symmetrical " molecules. It is necessary to take into account the distances between the atoms in the molecules. The same considerations apply when the molecules are rotating about a definite axis. Hence it is probable that a crystal lattice containing rotating molecules will give a characteristic X-ray diagram, especially if the molecules have heavy peripheral atoms. L. A. W.

1260. Ionisation of Air by X-Rays. G. Reboul and F. Perrier. *Comptes Rendus*, 208. *pp.* 172–173, *Jan.* 16, 1939.—It is shown that the recombination of ions formed in air by X-rays is not, as is generally supposed, complete a few seconds after the removal of the X-ray source, but continues for several hours. The number of slow ions produced reaches a maximum some minutes after the incidence of the rays and then slowly decreases. The phenomenon is explained on the assumption of the formation of large ions postulated by Langevin. N. M B.

1261. Intensity and Polarisation in the Continuous X-Ray Spectrum. G. Elwert. *Ann. d. Physik*, 34. 2. *pp.* 178–208, *Jan.*, 1939.—The problem of X-radiation is generally solved in the approximation of the matrix elements and for the pure Coulomb field of the retarding nucleus. It is a development according to a given magnitude which is only a function of the position in the spectrum. It converges best towards the long-wave boundary, but can be used in the greater portion of the spectrum. J. J. S.

1262. Fine Structure of X-Ray Absorption Edges of Al and Zn. J. E. Johnston. *Cambridge Phil. Soc., Proc.* 35. *pp.* 108–113, *Jan.*, 1939.—The fine structure of the Al L_{23}- and Zn M_{23}-absorption edges has been determined using the experimental methods described in an earlier paper [see Abstract 3636 (1937)]. A table containing numerical data for the Al and Zn edges, together with revised data for the edges of Li, Mg, Ni and Cu is included. AUTHOR.

***1263. Use of Imperfect Crystals in X-Ray Spectroscopy. J. M. Bačkovský.** *J. de Physique et le Radium*, 9. *pp.* 471–478, *Nov.*, 1938.—The resolving power of an imperfect mosaic crystal employed in a symmetrically disposed spectrograph is studied (*i.e.*, slit-crystal distance equal to crystal-plate distance). The angular spread of the line for this arrangement $= 2(\Delta\sigma)^2 \cot \phi$, due to the mosaic structure, manifests itself in the direction of shorter wave-length. For a NaCl crystal and Cu Kα, the broadening of the line amounts to about 2% of the normal magnitude of the line, *i.e.*, about 0·008 X ·U. This value is much below the limit of

the errors of observation ; hence the effect of the mosaic structure of the crystal using a symmetrical spectrometer is practically eliminated when the angle ϕ is sufficiently large. With an asymmetric arrangement the broadening is appreciable and permits the evaluation of the degree of mosaic imperfection. For this type of instrument it is necessary to use perfect crystals. C. J. B. C.

***1264. Bent Crystal Transmission Spectrograph for Focusing Hard Radiation. H. Jupnik.** *Rev. Sci. Instruments*, 10. *pp.* 32–33, *Jan.*, 1939.—In the instrument described, quartz crystals bent to a radius of approximately 1 m. are used. The geometry of the system is developed, and the K series of W was photographed as a test showing fair resolution of the β_3- and β_1-lines. N. M. B.

***1265. Curved-Crystal Ionisation Spectrometer for X-Rays. S. T. Stephenson.** *Rev. Sci. Instruments*, 10. *pp.* 45–46, *Feb.*, 1939.—The ionisation method is applied to the curved-crystal spectrograph. The ionisation chamber is mounted behind a slit moving in the focal cylinder. Tests on the Mo Ka_1a_2 doublet indicate better intensity than that obtainable with the usual Bragg spectrometer for a given resolving power. The best line widths are not as narrow as those obtainable with a double-crystal spectrometer. AUTHOR.

1266. Emission of X-Rays in Electrodeless Discharge. L. Groven. *Comptes Rendus*, 208. *pp.* 182–183, *Jan.* 16, 1939.—Hg vapour is subjected to electrodeless discharge, and after the removal of charged particles by an electric field, absorption measurements are carried out upon the X-rays emitted. The coefficient of absorption corresponds to a wave-length of 5·7 Å. This value remains constant for variations of intensity in the ratio 64 to 1, for variations of the tube diameter from 5 to 30 mm. and for variation of the exciting wave-length from 7 to 35 m. Diminution of the distance separating the external electrodes causes no change in the wave-length of the X-rays until a certain critical distance is reached, when the value drops rapidly to a new constant value of 3·5 Å. L. A. W.

See also Abstracts 891, 910, 1095, 1154, 1363, 1391.

HEAT.

CALORIMETRY.

1267. Application to Nickel of a New Method of Determining True Specific Heats. L. Néel. *Comptes Rendus*, 207. *pp.* 1384–1386, *Dec.* 27, 1938.—The specific heat of a pure Ni cylinder has been determined at constant pressure by an electrical method at temperatures up to 540·1°. There is a sudden change in the specific heat at 357·5 ± 1°. The Curie point of the specimen of Ni was determined to be 357·9°. A. J. M.

1268. Specific Heat and Fluctuations of the Molecular Field. L. Néel. *Comptes Rendus*, 208. *pp.* 177–179, *Jan.* 16, 1939.—The factors controlling the specific heat at constant volume of a metal such as Ni are considered, and reference is particularly made to the magnetic term introduced by the interaction between electron spins, *i.e.*, by the molecular field. This term varies rapidly with temperature above the Curie point. The specific heat excess due to fluctuation of the molecular field is calcu-

lated, the values obtained agreeing satisfactorily with experiment in the case of Ni. The theory of Weiss is thus confirmed. A. J. M.

1269. Specific Heats at Low Temperatures of Mn, MnSe and MnTe. K. K. Kelley. *Am. Chem. Soc., J.* 61. *pp.* 203–207, *Jan.*, 1939.—Specific heat measurements covering the temperature range 53° K. to room-temperature have been made for Mn, MnSe and MnTe. The last two substances behave anomalously. The following entropy values are given: Mn, $S_{298\cdot1} = 7\cdot61 \pm 0\cdot06$; MnSe, $S_{298\cdot1} = 21\cdot7 \pm 0\cdot5$; and MnTe, $S_{298\cdot1} = 22\cdot4 \pm 0\cdot5$. Free energy of formation values at 298·1° K. are computed for MnO, MnS and MnSe. AUTHOR.

See also Abstracts 1293, 1386.

CONDUCTION.

***1270. Thermal Conductivities of Gases by Hot Wire Method. G. G. Sherratt and E. Griffiths.** *Phil. Mag.* 27. *pp.* 68–75, *Jan.*, 1939.—The hot wire method offers several advantages over the plate method for measurement over a range of temperatures, but its disadvantages are the incomplete knowledge of the temperature discontinuity at the wire if a fine wire is used, and the corrections if a thick wire is used. In the apparatus described special heaters are arranged at the ends of the wire so that these corrections are eliminated. Details of the apparatus and method are given together with tables of results for air, CO_2, and Freon (tradename for dichlorodifluoro-methane). Values of ϵ are calculated from the equation $K/\eta C_v = \epsilon$, where K is the thermal conductivity, η the viscosity and C_v the specific heat at constant volume, and these are compared with the values obtained from an equation suggested by Eucken, $\epsilon = (9\gamma-5)/4$, where γ is the ratio of the specific heats. The temperature range covered is from 0° to 300° C. E. H. D.

1271. Thermal Conductivity and Thomson Coefficient of W and Mo at Incandescent Temperatures. R. H. Osborn. *Univ. of Pittsburgh, Bull.* 35. *pp.* 212–218, *Oct.* 1, 1938.—The thermal conductivities and Thomson coefficients of W and Mo in the region 1000° K. to 2000° K. have been obtained by an optical pyrometer method. Spectroscopic examination of the samples of W and Mo used showed that they were free from any but the slightest traces of impurities. Values of the Lorenz number ($k/\sigma T$, where k is the thermal conductivity, σ the electrical conductivity and T the absolute temperature) for different temperatures are also given. The thermal conductivities, Thomson coefficients and Lorenz numbers decrease with increase of temperature, the thermal conductivities being linear functions of the temperature. S. W.

See also Abstract 1283.

CONVECTION.

See Abstract 1069.

DILATATION.

1272. Dilatation of Heavy Water. K. Stokland, E. Ronaess and L. Tronstad. *Faraday Soc., Trans.* 35. *pp.* 312–318, *Feb.*, 1939.—The relative densities and volumes of 100% D_2O between 10 and 27° C. have been measured and tabulated. Using the figures obtained, it is shown that the densities of 100% D_2O with normal O^{18}/O^{16}-ratio at 20° C.

found by Tronstad and Brun and at 25° C. by Taylor and Selwood do not agree. The new value for the density at 25° C. based upon $d_{20}^{20} = 1 \cdot 10726 \pm 0 \cdot 00001$ and the present data of the relative volumes is $d_{25}^{25} = 1 \cdot 10764 \pm 0 \cdot 00001$. The temperature of the maximum density of D_2O has been found to be $11 \cdot 23 \pm 0 \cdot 02°$ C., and the densities of D_2O with normal and enriched O^{18}-content at this temperature have been calculated. Further, the supposition of A. Farkas that the difference of the densities of D_2O and H_2O has a maximum at 25° C. is shown not to hold good. AUTHORS.

1273. Estimation of Quartz by Differential Thermal Analysis. F. Trombe. *Comptes Rendus*, 207. *pp.* 1111–1113, *Dec.* 5, 1938.—The identification of different types of silica is carried out by a study of the coefficient of dilatation. The purpose of the present investigation is the estimation of quartz in a powdered mixture by a precision thermal analysis of the α-β transformation. The effect is studied by means of differential thermocouples. C. J. B. C.

1274. Expansion of Solids at Low Temperatures. Part II. H. D. Erfling. *Ann. d. Physik*, 34. 2. *pp.* 136–160, *Jan.*, 1939.—An experimental and theoretical investigation is made of the normal and abnormal relationship between atomic heat and thermal expansion coefficient of regular and irregular crystalline elements and their combinations. The Debye equations showing the values of the coefficient of expansion between two temperatures are satisfactory for normal regular crystalline elements, *e.g.*, Mo and Rh, between −215° and + 20° C. Cr and Mn are abnormal in that the coefficient for Cr above 0° C. has a well defined minimum the cause of which is unknown. The β-modification of Mn shows a sharp decrease with increase of N_2. For irregular crystals such as Be, graphite, Bi, Sb and Sn the coefficient does not definitely depend upon the atomic heat. For these a Debye function exists which is not the case for Zn and Cd. The complete results are set out in tabular form. Calc-spar gives an interesting result and has a very small coefficient at 0° C. and below −11° C. is negative and remains so until −85° C., when it becomes positive. [For Part I see Abstract 2785 (1936).] S. G. B.

1275. Expansion of Ground-Coat Enamel Frits. W. N. Harrison, B. J. Sweo and S. M. Shelton. *Bureau of Standards, J. of Research*, 22. *pp.* 127–136, *Feb.*, 1939.—Thermal-expansion determinations were made on 11 sheet-iron ground-coat frits of the single-frit type, using the interferometer and also a quartz-tube dial-indicator apparatus. "Critical" temperatures for both heating and cooling were determined. Mean coefficients of expansion from 25° to 400° C., and total contraction from the critical temperatures to 25° C. during cooling were correlated with variations in composition. Total differential contractions between enameling-type iron and the frits were also computed and correlated with variations in composition. Constants were determined which, when substituted in simple first-order equations, permit the computation of the expansivity of each frit at any temperature or temperature interval between 25° C. and the critical temperatures. The observed difference in the critical temperature on heating and that on cooling, the difference in the temperature-expansion curve of highly strained specimens below the critical temperature in heating, and the shrinkage of annealed specimens when held 30° C. below the critical temperature for heating, are explained by the work of Tool, Lloyd, and Merritt on glass [see Abstract 541 (1931)]. AUTHORS.

FUSION AND SOLIDIFICATION.

1276. Mechanism of Fusion. R. Lucas. *Comptes Rendus*, 207. *pp.* 1408–1410, *Dec.* 27, 1938.—The starting point of this investigation is the equation of Sutherland, $\mu = \mu_0[1 - (T/T)_f^2]$, where μ is the rigidity and T_f the temperature of fusion. By developing this in terms of pressure it can be shown that if dT_f/dp is positive the solid is subjected to an internal breaking force and if dT_f/dp is negative it is subjected to a breaking force of an external nature. This is in agreement with the recent ideas of L. Brillouin [see Abstract 67 (1939)] regarding the microscopic and the microscopic modulus of rigidity. It is not possible to consider rigorously the case of a crystal, but approximations can be obtained. It is possible to deduce reasons for the existence of a stable microcrystalline state at temperatures above the temperature of fusion of the microscopic crystal. G. G.

1277. Freezing and Boiling Points of Aqueous Mixtures of Ethylene Glycol. R. Delaplace and C. Béchard. *Comptes Rendus*, 208. *pp.* 103–105, *Jan.* 9, 1939.—These experiments have been carried out in connection with the cooling of high-powered aero engines. Freezing points are given for mixtures of different composition, some of these being syrupy transparent liquids, others not being transparent. Boiling points have been determined for different compositions and at pressures equivalent to heights of 2000, 5000, and 8000 m. E. H. D.

1278. Structure and Melting of Long Chain Ketones. J. W. H. Oldham and A. R. Ubbelohde. *Faraday Soc., Trans.* 35. *pp.* 328–337, *Feb.*, 1939.—The freezing-points of long chain ketones are found to depend in a marked way on the position of the CO dipole in the chain, higher freezing-points being observed when the dipole is near one end of the chain, or symmetrically in the middle. Cryoscopic determinations of the latent heat of fusion, and entropy increase on fusion, do not suggest any fundamental change of structure as the position of the dipole is varied. X-ray powder photographs show that the crystal structure is closely similar to that of the corresponding paraffins. Differences in the freezing-point must be connected with the influence of layers of dipoles on melting. A comparison of ketones $C_{17}H_{34}O$ with the paraffin $C_{17}H_{36}$ shows that the average contribution of these dipole layers to the heat of fusion is about 3·2 kg.cal./mole, whereas for $(C_8H_{17})_2CO$ the contribution to the total lattice energy is about 5·3 kg.cal./mole. The dependence of the melting-point on the position of the dipole layers suggests the possibility that the activation energy of melting is supplied by the torsional oscillations of the carbon chains in the crystal. Other experimental evidence supports this view. AUTHORS.

1279. Liquid-Solid Isotherm of a Tetra-Hydro-Naphthalene. under Pressure. J. Basset. *Comptes Rendus*, 208. *pp.* 169–170, *Jan.* 16, 1939.—The isotherm of tetra-hydro-naphthalene at 18°, for the pressure range 1 to 11,000 kg./cm², as determined experimentally, is given, and shows a sharp contraction in volume of 4·47% at the liquid→solid transition, the change of state corresponding to an increase of internal energy of 3·13 kg.cal. N. M. B.

1280. Ice Formation. C. L. Pekeris and L. B. Slichter. *J. of Applied Physics*, 10. *pp.* 135–137, *Feb.*, 1939.—A solution of the non-linear problem of the rate of ice formation on a long cylinder whose surface temperature is variable (but always below 0° C.) is given. The first-order

correction to the steady-state solution is evaluated and found to be small. As an example, application is made to a specific problem in freezing soil.
AUTHORS.

See also Abstracts 994 and
476B. Construction of Laboratory Furnaces. L. Walden.

TEMPERATURE.

1281. Effective Wave-Length in Optical Pyrometry. F. Hoffmann and C. Tingwaldt. *Zeits. f. Instrumentenk.* 59. *pp.* 20–30, *Jan.*, 1939.—The authors show how the effective wave-length of the colour filter in an optical pyrometer may be determined for different conditions of use, including the case when the unknown brightness is that of a grey radiator seen through an imperfectly neutral reducing filter. It is claimed that the results are obtained by clearer and simpler methods than those used previously. Pyrometers employing spectral selection of the light instead of colour filters are also considered and a formula for the appropriate effective wave-length is derived. W. S. S.

1282. Adiabatic Demagnetisation at Solid Hydrogen Temperature. N. Kürti, P. Laîné and F. Simon. *Comptes Rendus*, 208. *pp.* 173–175, *Jan.* 16, 1939.—It has been found possible to start from a temperature as high as that of solid H_2(8·5° Abs.) instead of from the usual liquid He, and with the high field of 29 kilogauss, obtained with a powerful electromagnet, to reach a temperature of 0·36° Abs. by the method of adiabatic demagnetisation. N. M. B.

1283. Momentum Transfer and Heat Flow in Liquid He II. J. F. Allen and J. Reekie. *Cambridge Phil. Soc., Proc.* 35. *pp.* 114–122, *Jan.*, 1939.—Experiments have been reported previously [see *Nature*, 141. *p.* 243, 1938] which show that, associated with a flow of heat in liquid He II, there is a pressure operative in the reverse direction to the heat flow. The effect can be seen when the channel through which the heat and liquid flow consists of a smooth-walled capillary, but in this case the reaction to the heat flow tends to be obscured by convection currents. A more pronounced effect is produced by enlarging the capillary and packing it with fine emery powder. In the present paper the authors describe experiments which are confined to the measurement of the reaction produced by the flow of heat through powder. The apparatus employed and the method of measurement of the reaction are described in detail. The heat was supplied electrically. The results obtained are shown by graphs, curves being given for the variation of the total conductivity and the reaction force with temperature gradient, the temperature dependence of the reaction force and of the conductivity, and the variation with temperature of the "velocity," *i.e.*, the ratio (flow of energy)/(transfer of momentum). In order to establish the connection between the direction of the heat flow and the momentum transfer, the emery powder was replaced by fine granules of iron-ammonium-alum, and the salt heated and cooled by magnetisation and demagnetisation. This showed that the direction of flow of the liquid is always in the reverse direction to that of the heat. Although none of the theories so far advanced gives a correct picture of He II, the authors' experimental data indicate that the essential idea underlying the theories of a momentum transfer accompanying heat flow is correct. S. W.

1284. "Film" Phenomenon of Liquid Helium II. B. V. Rollin and F. Simon. *Physica*, 6. *pp.* 219–230, *Feb.*, 1939. *In English.*—

After a discussion of the experiments which have led to the idea that a film is formed on surfaces in contact with liquid He II, further experiments on the anomalous evaporation from vessels containing liquid He II are described. It is concluded from the experiments that liquid He II "creeps out" of the containers in the form of a film and that this is responsible for the anomalous effects observed. [See also Abstract 2293 (1936) and following Abstract.] AUTHORS.

1285. Attainment of Low Temperatures by Pumping Liquid Helium II. B. S. Blaisse, A. H. Cooke and R. A. Hull. *Physica*, 6. *pp.* 231–239, *Feb.*, 1939. *In English.*—By pumping liquid He, temperatures below 0·8° K. have hitherto only been achieved with the aid of very large pump systems. Methods are here described by which the He evaporation is considerably reduced, so that this temperature region can be reached with ordinary pumps of 10 l./sec. capacity. The results obtained confirm the existence of a film of liquid He creeping out of the vessel and evaporating at the top [see preceding Abstract]. Besides extending the range of temperature easily accessible with liquid He, the new methods considerably increase the efficacy of the magnetic method for still further lowering the temperature. AUTHORS.

See also Abstracts 1202, 1293, 1350 and 511B. Lag in Thermometers. F. Lieneweg.

THERMOCHEMISTRY.

1286. Heat of Solution of Sodium Chloride in Methanol-Water Mixtures. R. L. Moss and J. H. Wolfenden. *Chem. Soc., J. pp.* 118–120, *Jan.*, 1939.—The heat of solution of NaCl at high dilution in methanol–water mixtures has been measured in an adiabatic calorimeter previously described. The results support the view that the ions are preferentially solvated by water but that methanol is not excluded from the solvent sheath except when the water concentration is comparatively high. AUTHORS.

1287. Propagation of Flame. J. B. Zeldowitsch and D. A. Frank-Kamenetzki. *Acta Physicochimica*, 9. 2. *pp.* 341–350, 1938. *In English.*—The older theories of the thermal propagation of flame by successive ignition of the gas mixture by the heat liberated in the reaction are unsatisfactory in that they use the conception of "ignition temperature" of the mixture. This ignition temperature is dependent on the properties of the mixture itself and the size and form of the containing vessel. A rational theory must therefore give the velocity of propagation as a function of the temperature and concentration of the reacting substances. Working with this object in view, formulæ are deduced for the velocity of propagation in the case of first- and second-order reactions. They are somewhat complicated, but are in terms of thermal conductivity, heat of activation, density, calorific value, specific rate of reaction, the gas constant and temperature. The presence of parallel reactions and the formation of intermediate products greatly restrict the application of these simple formulæ. G. G.

1288. Rôle of Peroxides in Formation of Cold and Hot Flames of Hydrocarbons. M. B. Neumann. *Acta Physicochimica*, 9. 3–4. *pp.* 527–580, 1938. *In English.*—New experiments are reported on the 2-stage spontaneous combustion of hydrocarbons over a pressure range from 0·1 to 60 atm. and a new type of pressure indicator suitable for dealing with the wide differences of pressure change is described. It is

found that increase of pressure causes a regular diminution of the times of induction of the formation of cold and hot flames, and that above a certain pressure the 2-stage character of spontaneous combustion vanishes. As the 2-stage region also has temperature limits, it is thus completely bounded both by temperature and pressure. This result also holds for certain O-containing compounds. The formation of a cold flame is considered to be due to the accumulation of a critical concentration of an intermediate product X, which then decomposes forming a large number of oxidation centres. Experiments on the effect of the addition of organic peroxides upon the induction period of cold flame production give evidence that the intermediate X consists of this type of compound. The mechanism of knocking is considered, and the results of experiments on the influence of anti-knock and pro-knock agents on the rate of hydrocarbon combustion are given. L. A. W.

1289. Inflammation of Gas Mixtures. R. Viallard. *Comptes Rendus*, 207. *pp.* 1405–1408, *Dec.* 27, 1938.—These experiments were carried out on mixtures of diethyl ether and air which were ignited by the condensed electric spark. Within the limits of inflammation the minimum voltage required to cause inflammation is determined for a definite capacity of the system. The curve of these values plotted against composition of the mixture passes through a minimum for the easiest inflammable mixture. This value was found to be dependent on the capacity of the system; the minimum energy $\frac{1}{2}CV^2$ was found to be variable. The form of the electrodes, which plays a great part in the distribution of the electric field, has a great influence on the value of the minimum energy. G. G.

1290. Ignition of Gases by Local Sources. H. G. Landau. *J. Chem. Phys.* 7. *pp.* 112–115, *Feb.*, 1939.—The theory of the ignition of gases previously given for spherical sources [*Chem. Rev.* 21. *p.* 245, 1937] is here extended to ellipsoid sources, including the sphere and infinite cylinder as special cases. The cylindrical case is important because a swiftly moving, hot particle may act as a cylindrical igniting source. The theory assumes that the source instantaneously heats up a small volume and creates in it active particles (chain carriers). Under general assumptions as to the processes which occur (but without including the temperature dependence of reaction rates), the temperature distribution is obtained and from the behaviour of the temperature at the centre of the source, a condition for ignition is derived in the form of a relation between the physical quantities involved. The results are similar to those previously obtained, one of the important differences being that, for the cylindrical source, ignition can occur without chain branching and without thermal self-acceleration of the reaction. AUTHOR.

See also Abstracts 966, 1017, 1361.

THERMODYNAMICS.

1291. Long Range Forces between Hydrogen Molecules. H. S. W. Massey and R. A. Buckingham. *Roy. Irish Acad., Proc.* 45*A*. *pp.* 31–45, *Nov.*, 1938.—At large distances of separation R the interaction energy between two symmetrical diatomic molecules with fixed orientations determined by the angles α, β, θ takes the form $V = G(\alpha, \beta, \theta)/R^5 - F(\alpha, \beta, \theta)/R^6$. The first term arises from static interaction of the molecular electric quadripoles and the second from dynamical dipole-dipole interaction of the type responsible for the van der Waals forces between

neutral atoms in S states. The form of the functions F, G is determined for any diatomic molecule and numerical magnitudes obtained for H_2 molecules, employing molecular wave-functions given by Wang and by Coulson in conjunction with variation and perturbation methods. In all cases $G(\alpha, \beta, \theta)$ averaged over all orientations of the molecules vanishes, but the average of F is finite. Comparison of this average value for H_2 with the empirical determination by Lennard-Jones of the van der Waals force in gaseous H_2 reveals good agreement. AUTHORS.

1292. Recent Theories of the Liquid State. N. F. Mott and R. W. Gurney. *Phys. Soc., Reports*, 5. *pp.* 46–63, 1938.

***1293. Heat. R. W. Powell.** *Phys. Soc., Reports*, 5. *pp.* 164–181, 1938.

1294. Physical Science of Heat. Part II. A. Eucken. *Die Physik*, 7. 1. *pp.* 13–34, 1939.—This paper includes a brief discussion on the following :—Equations of state of homogeneous systems (classical and quantum) for gases, liquids and solids ; variation of molar heat with temperature ; Joule-Thomson effect ; molar heats of liquids and solids of different numbers of atoms per molecule ; phase transformations in single component systems ; latent heats ; chemical equilibria, etc. Numerous references are given. [For Part I see Abstract 3118 (1935).] E. H. D.

1295. Real Gas Theory. M. Paul. *Zeits. f. phys. Chem.* 183. *Abt. A.* 5. *pp.* 321–339, 1939.—The effect of the motion of the gas molecules in the potential field has been investigated with regard to its effect on the equation of state. The effect appears in the fourth virial coefficient and it cannot be neglected with gases of high density. The equations of state evolved are allied to those of Dieterici and van der Waals. The departures of real gases are due to the different electrical structure of the molecules. Consideration of the virial coefficients and the attractive forces enables the real gases to be divided up into distinct classes, and the values of the van der Waals constant b is calculated for NH_3, CO_2 and H_2O. The significance of the values is discussed. E. H. D.

1296. Saturation State of Water from 350° C. up to the Critical Temperature. H. Eck. *Phys. Zeits.* 40. *pp.* 3–15, *Jan.* 1, 1939.—Specific volumes of saturated water and water vapour are measured by a direct method in the temperature range from 350° C. up to the critical temperature, which is found to be $374 \cdot 2_3$° C. The critical volume is found to be $3 \cdot 065_6$ cm³. per gm. The observed results are smoothed and presented in tabular form together with thermodynamically calculated values of the heat of vaporisation. In another apparatus the critical pressure of H_2O is found to be $225 \cdot 5_1$ kg. per cm². From measurements on H_2O and mixtures of H_2O and D_2O the following values are derived for the critical constants of D_2O : $T_k = 371 \cdot 5$° C. ; $v_k = 2 \cdot 74$ cm³. ; $p_k = 221 \cdot 5$ kg. per cm². The effect of gravity, temperature differences and the solubility of quartz in water upon the volume measurements in the immediate neighbourhood of the critical temperature are investigated. L. A. W.

1297. Vapour Pressure and Critical Constants of Normal Butane. J. A. Beattie, G. L. Simard and Gouq-Jen Su. *Am. Chem. Soc., J.* 61. *pp.* 24–26, *Jan.*, 1939.—The vapour pressure of normal butane has been measured from 75 to 150° by 25° intervals. Normal butane confined in a glass vessel by means of Hg does not decompose perceptibly at temperatures up to 300°. The critical constants of normal butane (C_4H_{10}, mol. wt. 58·077) are : $t_c = 152 \cdot 01 \pm 0 \cdot 01$° (Int.), $p_c = 37 \cdot 47 \pm 0 \cdot 02$ normal atm., $v_c = 0 \cdot 258$ l. per mole (4·44 cc. per gm.),

$d_c = 3{\cdot}88$ moles/l. (0·225 gm. per cc.). The uncertainty in the critical volume and density is 1%. AUTHORS.

1298. Compressibility of and Equation of State for Gaseous Normal Butane. J. A. Beattie, G. L. Simard and Gouq-Jen Su. *Am. Chem. Soc., J.* 61. *pp.* 26–27, *Jan.*, 1939.—The compressibility of gaseous normal butane has been determined over the temperature range 150 to 300° and from a density of 0·5 to 8·5 moles/l. The values of the constants of an equation of state are determined from the data for densities less than the critical (3·88 moles/l.). AUTHORS.

1299. Heterogeneous Equilibrium in Binary Mixtures. R. Vogel. *Zeits. f. phys. Chem.* 183. *Abt.A.* 5. *pp.* 340–344, 1939.—A discussion of the results of E. Jänecke [see Abstract 4592 (1938)]. This follows from two exceptions to the phase rule in systems with vapour pressure maxima and partially soluble mixed-crystal structures of which the components follow, under determined boundary conditions, from the Gibbs law. Diagrams are given to illustrate the system under discussion. E. H. D.

1300. Grand Partition Functions and "Thermodynamic Probability." E. A. Guggenheim. *J. Chem. Phys.* 7. *pp.* 103–107, *Feb.*, 1939.—The relation due to Boltzmann between entropy and "thermodynamic probability" is enunciated in a precise form. This relation is generalised in such a way that each of the other thermodynamic potentials is related in a similar manner to a "thermodynamic probability," for which a more suitable name is a "partition function." AUTHOR.

1301. Thermodynamics of HCl in Dioxane-Water Mixtures from E.M.F. Measurements. Part VIII. H. S. Harned, F. Walker and C. Calmon. Part IX. H. S. Harned and F. Walker. Part X. H. S. Harned, J. O. Morrison, F. Walker, J. G. Donelson and C. Calmon. *Am. Chem. Soc., J.* 61. *pp.* 44–54, *Jan.*, 1939.—[See also Abstract 4597 (1938).]

***1302. Improved Wiegand Rubber Pendulum. L. A. Wood and N. Bekkedahl.** *Rev. Sci. Instruments*, 10. *pp.* 51–52, *Feb.*, 1939.—A description is given of improvements and details of operation of a rubber heat engine of the pendulum type invented by Wiegand. The pendulum is kept in continuous operation by heat energy emitted by a radiant heater and intermittently absorbed by rubber bands. The major features of improvement in the design are essentially (1) increased mechanical stability, (2) decreased size and weight, and (3) considerable simplification of parts. AUTHORS.

1303. Theory of Relaxation Phenomena. R. de L. Kronig. *Zeits. f. techn. Physik*, 19. 12. *pp.* 509–516, 1938.—In relaxation problems the chief question which arises is how quickly thermodynamic equilibrium is set up among a large number of similar parts of systems (atoms, molecules, dipoles, spins, etc.). Essentially there is a mechanism of reciprocal action which gives a finite probability for the transformations between the steady conditions (vibrations, rotations, etc.). It is the task of the atomic theory to take account of the manner and magnitude of this reciprocal action and assess the dependence of the relaxation on the different variables (pressure, temperature, etc.). The present papers show to what extent this has succeeded. [See Abstracts 1324 and 1400 (1939).] G. E. A.

See also Abstracts 920, 958, 994, 1324, 1362, 1400.

VAPORISATION AND CONDENSATION.

***1304. Molecular Distillation. E. W. Fawcett.** *Kolloid Zeits.* 86. *pp.* 34–50, *Jan.*, 1939.—The relation between vacuum distillation and molecular distillation is discussed in some detail from a theoretical point of view in the first part of the paper. The second part deals with the practical construction and use of suitable apparatus. Other sections consider degassing, pressure measurement and fractionating. The final section deals with some chemical processes involving molecular distillation. A Bibliography is appended. E. H. D.

1305. Comparative Method of Measuring Vapour-Pressure Lowering. E. N. Lassettre and R. G. Dickinson. *Am. Chem. Soc., J.* 61. *pp.* 54–57, *Jan.*, 1939.—A comparative method of determining vapour pressure lowering is described which makes use essentially of the distribution of a volatile solvent between two non-volatile solutes. The accuracy of the method in its present form is better than 1% in solutions as dilute as 0·1 *M*, and the method is comparatively flexible. The concentrations of solutions of phenol in benzene and solutions of naphthalene in benzene having the same benzene vapour pressure are determined at 25 and 50°, and are discussed in terms of polymerisation. An approximate value of 2400 cal./mol. for the heat of dissociation of the dimer of phenol is obtained. Authors.

See also Abstracts 889, 1011, 1202, 1277, 1299.

ACOUSTICS.

1306. Propagation of Waves Due to Explosion in Liquids and Solids. O. v. Schmidt. *Zeits. f. techn. Physik*, 19. 12. *pp.* 554–560, 1938.—There is first described the occurrence of the seismic "head-wave," which has not yet been satisfactorily explained. Experiments are made with two liquids, *e.g.*, xylol and NaCl solution. A spark is produced at the surface of separation of the liquids, and the progress of the pressure wave is recorded by kinematograph. Two hemispherical waves spread out in the two media at different speeds, and a third wave is found in the xylol which moves with the edge of the wave in NaCl solution and is tangent to the slower wave in xylol. The sine of the angle which this head-wave makes with the boundary of the two liquids is equal to the ratio of the two velocities, *e.g.*, 1175/1600. Among other results obtained are the following: the head-wave also appears between a liquid and a solid. The longitudinal and transverse waves in a solid produce two head-waves in a liquid, which offers a new method for determining elastic constants. The method can be applied to models in water to investigate complicated acoustic and seismic waves. It may also be useful in the cases of optical total reflection and short radio wave propagation. Every kind of reflection and refraction may be regarded as a head-wave phenomenon. G. E. A.

1307. Vibration of a Ribbon of Metal or Other Material Excited by Air Currents. S. Suzuki and Z. Miduno. *Phys. Math. Soc. Japan, Proc.* 20. *pp.* 926–950, *Nov.*, 1938. *In English.*—The strength and nature of the tone produced by blowing air over a ribbon, which in most cases consisted of Mg, is investigated. The vibrations are found mainly

to be torsional, with a strong predominance of the fundamental tone if the wind velocity is not too high. The fact that the sound carries over great distances is explained by the fact that the motion of the ribbon sets the air column behind it in vibration and that therefore the vibrating object is actually much larger than the ribbon. An approximate formula for the frequency of torsional vibrations is given. R. P.

1308. Symmetrical Figures on Circular Plates and Membranes. R. C. Colwell, J. K. Stewart and A. W. Friend. *Phil. Mag.* 27. *pp.* 123–128, *Jan.*, 1939.—It is pointed out that the formulæ given by Kirchhoff for the vibration patterns of a circular plate namely $\{J_n(kr) + \lambda J_n(ikr)\} \cos n(\theta - \alpha_n) = 0$, and $J_n(kr) \cos n(\theta - \alpha_n) = 0$ are not general solutions of the equations of motion. A more general solution is obtained by adding two particular solutions and the new vibration forms to be expected on this basis are discussed, some of them being reproduced. Some of these have been observed experimentally and have been previously attributed to irregularities. It is shown that nodal designs similar to those shown by square plates may be expected round the rim of a circular plate. This leads to a complicated pattern which has been observed experimentally. J. E. R. C.

1309. Acoustic Resonators. H. Gemperlein. *Hochfrequenztechn. u. Elektroakustik*, 52. *pp.* 193–201, *Dec.*, 1938.—As a one-dimensional resonator an iron tube, with its ends closed by wooden plates, was investigated with a loud-speaker unit and condenser microphone. These were placed in front of holes in the end-plates. Records were taken by oscillograph for various frequencies, and these are shown and discussed, also the effects of reflected waves, and the mode of increase and dying away of the sound. A three-dimensional resonator in the form of a Lamé tetrahedron was investigated in a similar way to find to what extent such a resonator, of comparatively small dimension, could be applied in measuring sound absorption in different materials. G. E. A.

1310. Acoustical Properties of Violins. H. Meinel. *Zeits. f. techn. Physik*, 19. 11. *pp.* 421–425, 1938.—Experiments are described which were directed towards correlating the objectively-determined output from a violin with its quality as judged by musicians. Analyses are made of the output from a number of violins and the results discussed. A detailed comparison is made between a Stradivarius and another violin. It is concluded that the ratio between the fundamental tone and the overtones having frequencies exceeding 3000 $\sim$ is larger for good violins. It also appears that for the tone to be classed as good the output between 200 and 3000 $\sim$ should not vary by more than $\pm$ 20%. Modern "master-violins" have a smaller output at low frequencies and a greater output at high frequencies than old ones. The "dynamic," *i.e.*, the ratio between the greatest and least intensity generated, is also investigated for some violins. J. E. R. C.

1311. Force-Time Law Governing Impact of Hammer on Stretched String. N. Davy, J. H. Littlewood, and M. McCaig. *Phil. Mag.* 27. *pp.* 133–143, *Feb.*, 1939.—An attempt is made to measure the instantaneous force of impact of a hammer on a string by a piezoelectric method, at any moment while the two are in contact. Kathode-ray oscillograms, equivalent to force-time diagrams, are exhibited for both soft and hard hammers. AUTHORS.

1312. Velocity of Sound in Binary Liquid Mixtures by Resonance. C. Sălceanu. *Comptes Rendus*, 208. *pp.* 83–85, *Jan.* 9, 1939.—

Using the resonance method previously described [see Abstract 798 (1938)] measurements were made of the velocity of sound in binary mixtures of (*a*) water and ethyl alcohol and (*b*) acetone and butyl alcohol. The values of Pagliani were used for the coefficient of compressibility β for the water and ethyl alcohol mixtures. The velocity is found to be a maximum (1570 m./sec.) for a density of 0·963. Up to this point the velocity-density curve is almost linear. The Newton-Laplace formula gives a maximum of 1600 m./sec. for a density of 0·978. The experimental curve for acetone and butyl alcohol also differs from that given by the Newton-Laplace formula. A maximum similar to that for water and ethyl alcohol was also observed in the case of mixtures of water and acetone, the corresponding density being again 0·963. A. W.

1313. Supersonics. L. Allegretti. *N. Cimento*, 15. *pp.* 397–415, *June*, 1938.—In this summary of existing knowledge of supersonic vibrations, the author describes the methods of production and detection based on magnetostriction and piezoelectricity, the diffraction of light by the medium traversed, supersonic interferometry, the variation with frequency of the velocity of propagation in gases and the theory of this variation depending on the finite time required for the translational energy of the molecules to be converted into internal energy. W. S. S.

1314. Diffraction of Light by Supersonic Waves. N. S. N. Nath. *Indian Acad. Sci., Proc.* 8*A. pp.* 499–503, *Nov.*, 1938.—An elementary theory of the diffraction of light by supersonic waves in liquids has been previously put forward by Raman and the author [see Abstract 3772 (1936)] which was developed under the restriction that a light beam undergoes no amplitude changes on its wavefront during passage through the supersonic field. This restriction enabled closed expressions to be obtained for the intensities of the diffraction orders, and later [see Abstract 5219 (1936)] the exact theory was developed without the restriction. The expressions however were very complicated, and it is the purpose of the present paper to point out an extreme case where closed expressions may be derived for the above intensities. While the elementary theory is valid in the low frequency region (5 to 6 Mc./sec. or less), the theory contained in this paper is valid in any frequency region so long as the supersonic field is not strong enough to excite the second and other higher orders. It is also found that in the very high frequency region, the first orders would be dominant over the higher ones. The paper is mathematical throughout. H. H. Ho.

1315. Sound Field Investigation by Means of Isochromats. E. Hiedemann and K. Osterhammel. *Indian Acad. Sci., Proc.* 8*A. pp.* 275–280, *Nov.*, 1938. *In German.*—By making sound fields visible, a very exact investigation of the emission from a source of sound becomes possible. An interference effect has been observed, within the space of a few wavelengths from the source, which has not been treated theoretically hitherto. With white light passing through the sound field, coloured pictures of the field have been obtained which can be exhibited in a large hall. In these, lines of equal amplitude appear as lines of the same colour, *i.e.*, as isochromats. Some of the colour photographs show the applicability of the method to the judging of the energy distribution over the field. G. E. A.

1316. Dispersion of Supersonic Velocity in Liquids. R. Bär. *Indian Acad. Sci., Proc.* 8*A. pp.* 289–293, *Nov.*, 1938.—No dispersion of the supersonic velocity is found for water between 7·5 and 52·5 Mc./sec. and for benzene between 7·5 and 21 Mc./sec. AUTHOR.

***1317. Supersonic Velocity in Gases and Vapours. Part II. S. K. K. Jatkar.** *Indian Inst. of Science, J.* 21*A*. 40. *pp.* 455–465, 1938.—Further evidence regarding the complexity of the wave-form in the Pierce interferometer in vapours, has been brought forth by reproduction of the typical records, which show variations of intensity and phase, due to diffraction effects. The anomalous results obtained are thus due to experimental method, rather than to any characteristic of the physical situation, such as complexity of the molecule and its structure, and the attendant absorption and dispersion. As a result of many experiments, only the narrow tube method has been found to be satisfactory for accurate determination of velocity. The following table shows the values of the velocity of sound in m./sec. at 49·42 kc./sec. in a few typical gases and vapours in a 1 cm. brass tube, at 685 mm. [See following Abstract.] AUTHOR.

1318. Supersonic Velocity in Gases and Vapours. Part III. S. K. K. Jatkar. *Indian Inst. of Science, J.* 21*A*. 42. *pp.* 477–487, 1938.—Working with tubes of diameters, 1·25, 1·1, 0·97, 0·95 and 0·64 cm. and with varying apertures, the distances between consecutive positions at which maximum reaction was shown at 49·47 kc./sec., was 0·426, 0·553, 0·708, 0·738 and 1·62 cm. respectively at 25°. The corresponding volumes are 0·522 c.c. for each tube, indicating that points of resonance depend on the integral volumes rather than on the wave-length, with a constant value for the conductivity of the neck. At 48·56 kc./sec. the resonating volumes are integral numbers of 0·535 cm^3. showing that the volumes are inversely proportional to the squares of the frequencies, as required by the formula of the Helmholtz resonator. When the neck of the resonator was changed from 0·14 to 0·2 cm. the resonance peaks were inverted, showing that the presence of a tuned resonator increased the intensity of oscillation of the crystal. The average interval (7·07 mm.), observed between two consecutive positions at which the quartz oscillator was brought into oscillation, and that (7·08 mm.) between two major peaks, observed in Part I [see Abstract 363 (1939)] in an open tube of 0·97 cm. dia. when the oscillations of the crystal (49·47 kc./sec.) were critically controlled, are due to volume resonance. [See preceding Abstract and Abstract 1431 (1939).] AUTHOR.

1319. Influence of Supersonic Waves on Thixotropy. N. Sata and N. Naruse. *Kolloid Zeits.* 86. *pp.* 102–105, *Jan.*, 1939.—An investigation of the influence of supersonic waves on thixotropic systems of Al_2O_3 showed that the time required for congelation after irradiation by supersonic waves was greater than after shaking by hand. These times increased with the age of the systems and reached limiting values in 1–2 weeks. They were found to depend not only on the age of the sols, but also on the total time of agitation, and on the frequency of the transformations. It was concluded that the irradiation effected a breaking up of aggregations of smaller particles, together with a change in the state of hydration of the systems, and in the distribution of adsorbed electrolyte. W. H. WAL.

1320. Comparison of Influence of Audible Sound and of Supersonic Waves on Colloidal and Two-Phase Systems. H. Freundlich and D. W. Gillings. *Faraday Soc., Trans.* 35. *pp.* 319–324, *Feb.*, 1939.—The effects on colloid and two-phase systems of supersonic waves of frequency 214 kc./sec. and of audible sound of frequencies 5000 $\sim$ and about 400 $\sim$ have been investigated. It is shown that there is a general qualitative identity of the effects produced under physically similar conditions, except at the lowest frequencies. Cavitation has been shown to be effective at a higher audible frequency; similar dispersion products

are obtained by irradiation at different frequencies, when cavitation occurs. The higher frequencies of the range investigated are more effective, but practical considerations sometimes favour the use of audible sound rather than supersonics. AUTHORS.

1321. Pressure Field around Head during Speech. H. K. Dunn and D. W. Farnsworth. *Acoustical Soc. of America, J.* 10. *pp.* 184–199, *Jan.*, 1939.—A single speaker in a seated position repeated a 15-sec. sample of connected speech, while r.m.s. pressure measurements were made in 13 frequency bands, and at 76 positions, in different directions and distances. The results are applicable to intelligibility and microphone placement problems. They show, in general, the greater variation with direction at higher frequencies. Directivity due to the size of the mouth opening appeared to enter above 5000 ~, the axis at these frequencies being about 45° below the horizontal, in front. Frequencies below 1000 ~ were found strongest directly downward from the lips, or nearly so. The power radiated in different directions has been calculated, and a summation gives a spectrum of the total speech power emitted by the mouth It is proposed that similar spectra for other speakers may be obtained from pressure measurements at a single point, using the relations discovered for this speaker. The necessity for protecting a microphone used close to the mouth, from the puffs of air accompanying the speech, is demonstrated and explained. AUTHORS.

***1322. Instrumental Aids for Defective Hearing. P. M. T. Kerridge.** *Phys. Soc., Reports*, 5. *pp.* 150–163, 1938.

1323. Perception of Subjective Tones. J. F. Schouten. *K. Akad. Amsterdam, Proc.* 41. 10. *pp.* 1086–1093, 1938.—It is well known that the ear sometimes perceives tones which do not correspond with any of the Fourier components of the objective sound. Of these subjective tones the difference and the summation tones are the best perceptible. When a pure tone of increasing intensity is presented to the ear, the tone quality gradually changes from a pure one to a harsh or rough one. This change of quality is generally ascribed to a generation of higher harmonics in the ear. Fletcher and v. Békésy have investigated these subjective harmonics by a beat method, but Trimmer and Firestone [see Abstract 4130 (1937)] criticise the use of the beat method as a quantitative method of measuring the subjective harmonics, especially so because the presentation of the exploring tone might change the amount of harmonics generated in the ear and might give rise to disturbing overtones and combination tones. Experiments here described seem to justify this criticism. An optical arrangement was used for sound production, the prescribed waveform being cut in stiff paper and scanned by means of a revolving disc furnished with 9 narrow slits. The light transmitted by the slits was transformed into sound by means of a photo-cell, amplifier and loudspeaker. Measurements of the intensity level of the fundamental tone and of the higher harmonics were carried out by means of an electrostatically calibrated condenser microphone and a wave analyser. At an intensity level of 105 db and an objective second harmonic of 4–8% a very marked phase effect upon the tone quality was observed, confirming the results of Chapin, Trimmer and Firestone. The addition of an exploring tone under certain conditions gave rise to disturbing beats. The presence of such beats, whose origin is somewhat uncertain, appears to confirm the criticism of the beat method. A. W.

1324. Acoustic Relaxation Phenomena. H. O. Kneser. *Zeits. f. techn. Physik*, 19. 12. *pp.* 486–492, 1938.—Acoustic relaxation occurs when, with rapid compression, the compressional energy communicated to a body is not distributed over all the degrees of freedom of the molecules as in thermal equilibrium. In consequence there is an apparent increase in compressibility and an increased velocity of sound; in addition, the cycle is irreversible for frequencies of the order of the reciprocal of the time of relaxation, and sound energy is absorbed. In gases the absorption of sound and dispersion phenomena have been observed and can be ascribed to the transformation of translational and rotational energy into energy of vibration. The appropriate period of relaxation is of the order 10^{-3} to 10^{-5} sec. The life of vibration quanta has a molecular-kinetic significance. In liquids there is also strong absorption of sound which is put down to relaxation, but a maximum of absorption has not been attained. Consequently only an upper limit can be given for the period of relaxation, namely 10^{-8} sec. and the significance of this still remains uncertain. [See Abstract 1303 (1939).] G. E. A.

***1325. Wave Analyser Giving Relative Amplitudes and Phases. Z. Carrière.** *J. de Physique et le Radium*, 10. *pp.* 14–22, *Jan.*, 1939.—A description is given of a method of analysing a.c. by mixing it with a pure tone of known variable frequency and observing the amplitude of the beats produced. By an electronic commutator the wave and the search tone can be observed simultaneously on a kathode-ray screen and this facilitates the adjustment. The phases can be observed at the same time. The paper concludes with a discussion of the mechanism of hearing directed towards explaining the fact that the quality of a tone does not depend upon the relative phases of its components. J. E. R. C.

***1326. New Microphotometer for Evaluation of Sound Films. A. Narath and K. Schwarz.** *Zeits. f. techn. Physik*, 19. 11. *pp.* 465–469, 1938.—The microphotometer has become indispensable in the evaluation and analysis of sound films, and an instrument is described which gives increased accuracy of measurement. A small area of the film is illuminated by a narrow slit, and the transmitted light is measured by means of a photo-cell and galvanometer. The optical and mechanical parts are described, and diagrams are given. G. E. A.

1327. Acoustic Spectra Obtained by Diffraction of Light from Sound Films. D. Brown. *Phys. Soc., Proc.* 51. *pp.* 244–255, *March*, 1939.—The theory of diffraction is applied to a generalised form of diffraction grating such as that provided by a variable-density sound film. The results indicate that under certain conditions the different frequency components in the original sound will be uniquely represented by spectral lines in the diffraction pattern, producing an acoustic spectrum. The theory of the method is shown to be of great generality, permitting an analysis of transient as well as of sustained sounds. The analogy between the optical effects and the original sound is developed in some detail, spectral ghosts being identified with the side frequencies which result from amplitude-modulated waves. The latter conception is also found of use in discussing the breadth and fine structure of the spectral lines themselves. Sound films are normally recorded with some form of optical shutter, which transmits light whose intensity is proportional to i, the amplified audio-frequency current, but it is shown that for films intended for acoustic analysis, the light-intensity must vary as i^2. Photographs of records made in this way are reproduced, together with the derived

acoustic spectra, which accord with the theory. Finally, the probable value of the method as an addition to existing methods of sound-analysis is discussed. AUTHOR.

1328. Sound. E. G. Richardson. *Phys. Soc., Reports*, 5. *pp.* 121–149, 1938.

See also Abstracts 957, 1350, 1430, 1431, and
679B. Investigation of Room Acoustics. F. V. Hunt.
681B. Apparatus for Audio Measurements. H. A. Chinn and V. K. James.
685B. Properties of the Resonance Disc. M. Kobayashi and T. Hayashi.
686B. A.C. Erasing on Magnetic Recording. K. Nagai, S. Sasaki and J. Endô.

ELECTRICITY AND MAGNETISM.

CONDUCTION AND DISCHARGE IN GASES.

1329. Development of Spark Discharge. Part II. T. E. Allibone and J. M. Meek. *Roy. Soc., Proc.* 169*A*. *pp.* 246–268, *Dec.* 22, 1938.—Further work on the development of the spark at pressures from 76 to 0·3 cm. Hg confirms the conclusions previously drawn [see Abstract 2544 (1938)] regarding the major differences between the positive and the negative spark discharge. Even for the longest gap (150 cm., breakdown voltage = 1600 kV) the negative discharge from a point electrode is always met by an ascending positive leader stroke from the earthed plane and the length of this leader is not less than 30% of the gap. In the case of the positive discharge the positive leader stroke is only infrequently met by an ascending negative leader stroke. The sub-atmospheric discharges afford assistance in the interpretation of the discharges at atmospheric pressure. The leader-stroke/main-stroke mechanism persists at least down to 5 cm. Hg with the same general distinction between positive and negative types of discharge. The individual stepped leader strokes become more sharply defined and more widely separated in time as the pressure is reduced down to 10 cm. Hg. At low pressures the positive leader predominates to an even greater extent than at atmospheric pressure. A comprehensive discussion is given of the results of numerous researches with impulse voltages by Rogowski, Flegler, Tamm, Krug and Kohler. Study of the effect of resistance on the velocity of propagation of leader strokes indicates that this is an important factor in discharge development. A. W.

1330. Spark Breakdown Potentials as a Function of the Product of Pressure and Plate Separation in A, N_2 and H_2 for Pt and Na Kathodes. F. Ehrenkranz. *Phys. Rev.* 55. *pp.* 219–228, *Jan.* 15, 1939.—Measurements were made of the sparking potentials between fixed plane parallel electrodes in purified A, N_2 and H_2, with Pt and Na kathodes and for an extended range of pressure. In all three gases the sparking potential is lower for a Na-coated Pt kathode than for a clean Pt kathode throughout the pressure range investigated. The percentage lowering, which is especially pronounced near the minimum sparking potential, decreases with increasing values of $p\delta$. In A the predischarge currents within a few volts of breakdown were less than 10^{-9} A for both Na and Pt surfaces and the effect of a Na kathode is in satisfactory agreement with Loeb's predictions from Townsend's theory. In N_2 Loeb's theory

is not applicable on account of the heavy predischarge currents. H^2 is intermediate between A and N_2 both with respect to the approach of the Na and Pt curves at high values of $p\delta$ and the magnitudes of the predischarge currents. A. W.

1331. Temperature of Electrons in a 50-Cycle A.C. Positive Column Discharge. W. Uyterhoeven and C. Verburg. *Comptes Rendus*, 207. *pp.* 1386–1388, *Dec.* 27, 1938.—In a positive column a.c. discharge the temperature T_e of the electrons should vary in a periodic manner with the discharge variables, namely, the voltage V_l at the electrode terminals and the discharge current C_l. A method is described which permits measurements to be made of T_e at any instant in the cycle. The method is based on the Langmuir and Mott-Smith probe method for d.c. discharges. A probe is connected through a suitable resistance to one of the electrodes and any desired p.d. is applied by means of a battery. The probe current is measured in successive periods for a time which is a very small fraction (about 1/100) of a half period. The instant can be adjusted to any point of the cycle and in this way, by varying the probe potential, a probe characteristic can be obtained for any particular phase angle. The selector arrangement makes use of a disc driven by a synchronous motor and carrying on its edge a tiny mirror. At each revolution a concentrated beam of light is reflected at some particular instant from the mirror on to a photo-cell, the amplified current from which is applied to a pentode which is used to control the triode-pentode arrangement used to measure the probe current. A. W.

1332. Temperature Distribution in High Pressure Mercury Discharge Tube. W. Elenbaas. *Phys. Rev.* 55. *pp.* 294–296, *Feb.* 1, 1939.—Several arguments are given which support the view that the temperature distribution of the vapour in the high pressure Hg discharge tube is not that given by Adams and Barnes [see Abstract 2116 (1938)]. but rather as indicated graphically by the author. AUTHOR.

1333. Probability of Ionisation of Hg Atoms by Collision with Low-Velocity Electrons. M. E. Bell. *Phys. Rev.* 55. *pp.* 201–202, *Jan.* 15, 1939.—Measurements of the electron velocity distribution and of the positive-ion current showing the onset of ionisation in a type of apparatus specially constructed for the experiments gave results in good agreement with those of Lawrence. Current was observed when the electron energy was less than the ionisation potential of Hg of 10·38 V, but subsequent work by Nottingham [see following Abstract] showed that this current was caused by the emission of photoelectrons from the ion collector and not by the ionisation of the Hg molecule or by the effects of some unknown impurity. A. W.

1334. Ionisation and Excitation Produced in Hg Vapour by Electron Bombardment. W. B. Nottingham. *Phys. Rev.* 55. *pp.* 203–219, *Jan.* 15, 1939.—The electronic excitation and ionisation functions of Hg were determined by means of special apparatus sufficiently free from spurious effects to permit the accurate determination of the energy of the bombarding electrons from the dimensions of the apparatus and the strength of the magnetic field. Secondary emission and related effects are briefly discussed. The ionisation probability function is shown to have two important maxima, the first at 10·8 V and the second at 32 V. The detailed structure between 10·4 V and 16 V indicates the composite character of the ionisation function for relatively low voltages, while the general smoothness of the curve above 16 V suggests a simpler

function for high energy electrons. Study of photoelectric currents gave new data on the electronic excitation function of the $2^3P_1{}^0$, $3^3P_1{}^0$ and $4^3P_1{}^0$ levels of the Hg atom, showing that these have maxima in their probability functions at 5·6, 8·9 and 9·6 V. [See preceding Abstract.] A. W.

1335. Critical Potentials of CO. J. Savard and M. de Hemptinne. *J. de Physique et le Radium*, 10. *pp.* 30–31, *Jan.*, 1939.—By electronic bombardment of CO a number of critical potentials have been measured. 15 exist below 13·2 V and these include all the minima of spectral activation energy. Between 13·5 and 20 V 23 critical potentials have been observed. The ionisation potential of CO, determined by observation of positive-ion current, is $13{\cdot}55 \pm 0{\cdot}05$ V. Above 20 V 30 critical potentials exist. The peculiar characteristics at 20 V suggest that it corresponds to the dissociation $CO \rightarrow C^+ + O_{normal}$. W. R. A.

1336. Electron Transfer in Mercury Vapour. F. L. Arnot and M. B. M'Ewen. *Roy. Soc., Proc.* 169A. *pp.* 437–450, *Feb.* 7, 1939.—An investigation of the electron transfer process $Hg^{2+} + Hg \rightarrow Hg^+ + Hg^+$ has been made using incident Hg^{2+} ions having energies from 140 to 400 eV. The internal energy set free in the collision by the capture of the electron is 8·28 eV, of which it is found that about 6·3 eV are employed in exciting one of the resulting Hg^+ ions, the balance of about 2 eV being shared as kinetic energy between the two Hg^+ ions in accordance with the law of conservation of momentum. The classical mechanics of the collision process show that the results obtained can be accounted for only by a head-on collision, one of the resulting Hg^+ ions remaining stationary and the other carrying off the full kinetic energy of the incident Hg^{2+} ion plus the total amount of 2 eV internal energy available in the form of kinetic energy. The cross-section for the process over the energy range of 140 to 400 eV has been obtained, and this shows an increase of cross-section with energy of the incident Hg^{2+} ion, the value at the middle of the energy range being of the order of one-tenth of the gas-kinetic cross-section for collision. AUTHORS.

1337. Substandards in Mass-Spectrography. J. Mattauch. *Zeits. f. techn. Physik*, 19. 12. *pp.* 578–582, 1938.—The most important substandards of reference in mass spectrography are the lines of ^{12}C, ^2D and ^1H; the isotopic weights of these substandards are determined by the doublet method with a higher accuracy than hitherto achieved. The double focusing Mattauch mass-spectrograph permits determination of these masses from a large number of mass doublets covering a wide range on a single photographic plate, its exceptional resolving power is exemplified by an illustration of lines in the region of mass 20 in which up to 8 components are resolved, the six most prominent being $^{40}A^{++}$, ^{20}Ne, $^{18}OH_2$, $^{16}OD_2$, $^{14}ND_3$ and $^{12}CD_4$. From measurements of the components of the mass 20 line new values of the masses of ^{14}N, ^{20}Ne and ^{40}A are obtained. All the measured results are compared with the results of Aston and of Bainbridge and Jordan; agreement is recorded throughout within the limits of their experimental error with Bainbridge and Jordan's scale; Aston's value for ^{12}C is almost certainly too low, 12·00355 compared with 12·00388. J. E. K.

***1338. Mass-Spectrography. L. Cartan.** *R.G.E.* 45. *pp.* 109–123, *Jan.* 28, 1939.—A review. L. A. W.

1339. Bands in Mass-Spectroscopy. J. Mattauch and H. Lichtblau. *Phys. Zeits.* 40. *pp.* 16–22, *Jan.* 1, 1939.—Besides the two bands interpreted by Aston, 26 further dissociation processes of molecules

occurring in canal rays (especially compounds of C, O and H) are observed and discussed. The displacement of the band maximima relative to the theoretical value is entirely explained as due to the stray magnetic field. All the facts suggest that the collision with residual gas molecules, which is the cause of the effect, involves no appreciable impulse transference. Amongst the changes of charge of atoms and molecules, some (like the dissociation processes) are due to collision with residual gas molecules, and others are caused by secondary electrons. In the latter case lines are produced, which generally appear as " ghosts " when the stray magnetic field is not screened. L. A. W.

***1340. Influence of Rate of Flow in Siemens Ozoniser. R. Krishnan and S. K. K. Jatkar.** *Indian Inst. of Science, J.* 21*A*. 41. *pp.* 467–475, 1938.—A simple design for an ozoniser has been described for utilising the balanced windings of the cheap neon sign transformer. The results of experiments conducted with pyrex ozonisers having an annular gap of 3 mm., at 8·5 kV yielded results which were comparable with a similar ozoniser having 4 mm. gap at 10 kV, and with the latter exciting voltage, the results were as good as those obtained with two 4 mm. gap ozonisers put in series. The soft glass ozoniser was nearly twice as efficient as the pyrex ozoniser. The results of experiments on the formation of O_3 from air in silent electric discharge by both static and dynamic methods were found to be in general agreement with the previous findings of the authors regarding the formation of atomic O. The equilibrium conditions were also found to depend upon the exciting voltage. The apparent percentage conversion of O_2, however, was found to be less for lower rates of passage at lower voltages, and at a particular rate, apparently no O_3 was obtained. Atomic O is apparently far more stable in air than in O_2, the proportion of O to O_3 being 2 to 1. The remarkable divergence in the values of equilibrium conversion observed between the static and the dynamic conditions at higher voltages, has been explained on the basis of the reducing action of atomic O on the reactions of O_3. [See also Abstract 4630 (1938).] AUTHORS.

See also Abstracts 1107, 1108, 1109, 1110, 1111, 1112, 1113, 1115, 1116, 1266, and 480B. Convection Currents in Arcs in Air. C. G. Suits.

CONDUCTION IN SOLIDS AND LIQUIDS.

***1341. Two Voltage Regulators. H. V. Neher and W. H. Pickering.** *Rev. Sci. Instruments*, 10. *pp.* 53–56, *Feb.*, 1939.—Two voltage regulators are described. The first is satisfactory where there is only a very small current drain; the second will maintain constant voltage output up to the current carrying capacity of the radio tube. For each the change of output voltage with change of input can be made zero. Where extreme constancy is required, the second circuit described is recommended. It approximates closely perfect regulation. The coefficient of voltage change of the output, defined by $(1/V_o)(\partial V_o/\partial V_i)$ where V_o is the output voltage and V_i is the input voltage, is less than 10^{-7} per volt. The regulation is equally as good for surges as for longer random or periodic fluctuations. The circuit also maintains a constant voltage output for varying current drains, the output resistance being about 10 ohms. Currents up to 100 mA at several thousand volts may be drawn with no significant change in the output voltage. The coefficient of drift defined by $(1/V_o)(\partial V_o/\partial t)$, where t is the time, will usually be less than

10^{-4} per hour even under normal laboratory conditions where no special precautions are taken. AUTHORS.

1342. Variation of Resistance with Temperature for Al and Cu. A. Avramescu. *Zeits. f. techn. Physik*, 20. 1. *pp.* 26–30, 1939.—Changes of electrical resistivity with temperature have been measured for high-conductivity Cu, and high-conductivity Al at temperatures up to the melting point. Cold-drawn wires of the metals were wound on fire-proof cores, and placed in an atmosphere of N_2 in an oven which could be heated up to 1050° C. The resistances were measured by means of the Kelvin double bridge. The results are expressed in the form: for Cu $\rho_\theta/\rho_0 = 1 + 0{\cdot}4241 \times 10^{-2}\theta + 0{\cdot}453 \times 10^{-6}\theta^2$, while for Al $\rho_\theta/\rho_0 = 1 + 0{\cdot}3867 \times 10^{-2}\theta + 1{\cdot}10 \times 10^{-6}\theta^2$, where ρ_θ denotes resistivity at θ° C. L. H.

1343. Current Effects in Cylindrical Supraconductors. A. D. Misener. *Cambridge Phil. Soc., Proc.* 35. *pp.* 95–107, *Jan.*, 1939.—Experiments are described which show the effect of current on the transition of cylindrical supraconductors to the normal state produced by increasing an external magnetic field. The transition curves were determined with an accuracy of 0·1%. Both longitudinal and transverse fields were used. The following results were found: (*a*) *Transverse field.* (i) The field strength at which the first traces of resistance appeared was independent of current strength for reasonably small currents (up to about 100 mA for 0·010 cm. wire). (ii) With increase of current the transition curve at first changed shape, becoming more and more nearly linear, and then was displaced parallel to itself toward smaller values of the applied field by an amount in accordance with Silsbee's hypothesis. (iii) The change in shape of the transition curve was accurately reproducible and was identical for specimens of the same material and diameter. (iv) The results for specimens of different diameter could be accurately correlated if the measured values of the resistance were plotted against the current divided by the specimen diameter raised to the power $(1 + R/R_n)$, *i.e.*, $I/(\text{diam.})^{(1+R/R_n)}$, where R/R_n is the ratio of the measured resistance to the resistance just above the transition point. (*b*) *Longitudinal field.* (i) With increase of current, however slight, the transition curve was displaced parallel to itself, toward smaller values of the applied field, without showing any change in shape. (ii) The displacement of critical field for a given change of current was completely independent of the diameter of the specimen. (iii) The observed shift to smaller fields was much greater than could be accounted for by the additional field produced by the current at the surface of the wire. (iv) If the (extrapolated) value of the critical field for zero current be denoted by (H_c) and the difference between this and the observed value for a current (I) by ΔH_c) then I and H_c are connected by the empirical relation $\Delta H_c = (A/H_c)I^{nHc}$, where A and n are constants depending on the nature of the supraconducting metal. For Sn, A = 220, n = 0·0022; for In, A = 240, n = 0·0029, where H_c is expressed in gauss and I in *m*A. AUTHOR.

1344. Electrical Conductance of Thin Metal Films. E. Perucca. *N. Cimento*, 15. *pp.* 365–376, *June*, 1938.—New measurements of the electrical conductance of sputtered films as a function of the thickness, are given for temperatures between 55° C. and 250° C. The film thickness is of the order 1000 Å. The influence of temperature on the form of the conductance-thickness curve is considerable; with increasing temperature, the existence of a point of inflection becomes more and more evident, confirming previous observations and providing additional evidence for the

granular theory proposed to explain the anomalous behaviour of thin metallic films (the reduction of the mean free path of the electrons; a deficiency in the number of conduction electrons). [See Abstract 2564 (1938).] C. J. B. C.

1345. Electrical Conductivity and Dissociation of Solutes in Liquid SO_2. G. Jander and H. Mesech. *Zeits. f. phys. Chem.* 183. *Abt. A.* 4. *pp.* 255–276, 1939.—In agreement with other investigators, it is found that limiting conductivity in this solvent is attained only at extraordinarily great dilution, and that the Ostwald dilution law is clearly valid for strong electrolytes, but only with $V > 8000$. The law of independent migration of the ions is also valid in infinitely dilute solutions in SO_2. Ionic velocity increases in the order $(CNS)'$, Br', I' $(ClO_4)'$, Cl', $[(CH_3)_4N]'$, $K^{\cdot}$, $(NH_4)^{\cdot}$, $Rb^{\cdot}$. With varying anions, dissociation and conductivity increase in the order—$(CNS)'$, $(ClO_4)'$, Cl', Br', I', $(SbCl_6)'$; with varying kations in the order—$Na^{\cdot}$, $(NH_4)^{\cdot}$, $K^{\cdot}$, $Rb^{\cdot}$, $[(CH_3)_3S]'$, $[(CH_3)_4N]'$, $[(C_2H_5)_4N]'$, $[(C_6H_4 \cdot CH_3)_3C]'$, *i.e.*, approximately in order of physical size, while no such correlation is possible with the anions. A decrease in temperature from 10° to − 33·5° C. causes a valley in the λ/log V plot at log V = 1·1 to become smoothed out; possible causes for this are discussed in relation to the effect of temperature on viscosity and solvation. [See also Abstract 890 (1939).] D. R. H.

1346. Passage of Current in Iodide of Copper. P. Vaillant. *Comptes Rendus*, 208. *pp.* 32–34, *Jan.* 3, 1939.—A cell of copper iodide was constructed from two plates of copper, covered with iodide of copper on about 2 cm. of their lengths. The two iodide-covered portions were pressed into contact with each other by means of two ebonite plates. Such a cell had a thickness of a few tenths of 1 mm., and a conductance of some tenths of 1 mho. It was found that the conductance varied within a considerable range with the intensity of the current passing between the plates, and its duration and with the temperature. F. J. B.

***1347. Conductivity Measurement by Heterodyne Method. E. Guggolz.** *Zeits. f. Elektrochem.* 45. *pp.* 229–235, *Feb.*, 1939.—A description is given of a type of measuring cell, consisting of a spiral tube surrounded by a liquid mantle, for the measurement of the h.f. conductivity of liquids by the heterodyne method. The use of this type of cell makes such measurements possible by means of the usual apparatus for dielectric constant determination. The factors involved in the measurements and the sources of error are discussed. It is noted, with examples, that conductometric titrations can be carried out with the cell described. L. A. W.

1348. Behaviour of Semiconductors in H.F. Fields. P. Henninger. *Zeits. f. techn. Physik*, 19. 12. *p.* 597, 1938.

***1349. Absolute Electrical Measurements. L. Hartshorn.** *Phys. Soc., Reports*, 5. *pp.* 302–333, 1938.

***1350. Electrical Measuring Instruments. G. A. Whipple.** *Journ. Sci. Instruments*, 16. *pp.* 58–64, *Feb.*, 1939.—A review of exhibits of electrical instruments at the Physical Society's Exhibition, 1939.

See also Abstracts 906, 923, 1349.

DIELECTRICS AND CAPACITANCE.

1351. Dielectric Constants and Internal Pressures of Non-Polar Liquids. D. I. Coomber. *Faraday Soc., Trans.* 35. *pp.* 304–307, *Feb.*, 1939.—It is found that the relation between the dielectric constant and the

calculated internal pressure for a number of non-polar liquids is approximately linear, the liquids with higher internal pressure having higher dielectric constants. The relationship is more nearly linear at high temperatures such as 200° C. than at 20° C., and it is suggested that at the lower temperatures the actual internal pressures are different from the calculated pressures owing to the decreased molecular spacing at these temperatures. E. R.

1352. Dielectric Relaxation and Dispersion in Liquids. J. Malsch. *Zeits. f. techn. Physik*, 19. 12. *pp.* 526–531, 1938. Recent measurements by various authors of the dielectric constant of liquids in high fields and of the absorption of short electric waves in liquids are discussed and it is concluded that a simple dipole theory is insufficient to account for the observed variation of dielectric saturation with temperature. The simple theory is developed by assigning to the liquid a structure possessing a relaxation time. K. M. C.

1353. Influence of Molecular Structure on Dielectric Relaxation. E. Fischer. *Zeits. f. techn. Physik*, 19. 12. *pp.* 531–534, 1938. The connection between dielectric relaxation time and the structure of dipole-molecules is investigated by measuring the dielectric losses in dilute solutions of benzene or anthracene derivatives in benzene. The results agree better with a formula of Perrin according to which the molecules are ellipsoidal than with a formula based on the assumption that the molecules are spheres of varying diameter. The relaxation time for molecules with dipole groups capable of free rotation is less than that of equally large molecules with a rigid dipole ; this is explained on the assumption there are two types of friction, one concerned with the rotation of the molecule as a whole and the other with that of the dipole groups which are capable of free rotation. K. M. C.

1354. Relaxation Time in Dielectrics. E. Plötze. *Zeits. f. techn. Physik*, 19. 12. *pp.* 534–538, 1938.—Measurements of the dispersion of the dielectric constant of dilute polar solutions are made and qualitative agreement is claimed with Debye's theory of relaxation time. K. M. C.

1355. Relaxation Time in Dielectrics and Inertia of Kerr Effect. O. Maercks and W. Hanle. *Zeits. f. techn. Physik*, 19. 12. *pp.* 538–541, 1938.—It is pointed out that the existence of permanent dipoles in fluids must, owing to intermolecular friction, give rise to double refraction which exhibits " inertia " ; a decrease in the Kerr Effect is then to be expected at high frequencies, and also a phase difference between the Kerr Effect and the voltage. An experimental arrangement is described for the measurement of this phase difference. The relaxation-time can then be calculated. Values of the relaxation-time so obtained for various organic liquids are given and compared with those obtained by other authors. K. M. C.

See also Abstracts 937, 993.

ELECTROCHEMISTRY.

1356. Ag-Pt Contacts in Aqueous Iodides. S. Veil. *Comptes Rendus*, 207. *pp.* 1388–1390, *Dec.* 27, 1938.—The contact Ag-Pt in saturated solutions of LiI, NaI, KI, NH_4I, CaI_2, SrI_2, or BaI_2 gives in each case practically the same e.m.f. (0·73–0·75 V) ; in saturated solutions of ZnI_2 and CdI_2 it is slightly less (0·63 and 0·66 V) ; but much less if the I is part of a complex ion, *e.g.*, in solution of KIO_3 about 0·5 V and in one K_2HgI_4 0·1 V. This is attributed to the electronic constitutions

of the elements concerned. The relatively great importance of the I^- ion is further shown by the fact that the e.m.f. of the cell — Ag | KI | gelatin | Pt + is of the order 0·6 V, of + Pt | KI | gelatin | Ag — only 0·1 V, and of — Ag | KI | gelatin | Ag + 0·33 V, the Ag pole (or, if both poles are Ag, the one in contact with KI) being negative. C. A. S.

1357. Activity Coefficients from Concentration-Cell Potentials. T. Shedlovsky and D. A. MacInnes. *Am. Chem. Soc., J.* 61. *pp.* 200–203, *Jan.*, 1939.—Measurements have been made on the potentials of $LaCl_3$ concentration cells with transference from $C = 0{\cdot}0006$ to $0{\cdot}0333$ mole/l. at 25°. From these data and accurate transference numbers, activity coefficients have been computed. The results do not appear to be in harmony with the available equations based on the interionic attraction theory since the values decrease less rapidly with increasing concentration than the theory predicts. Osmotic coefficients obtained from these results have been shown to be consistent with recent isopiestic measurements. [See Abstract 2232 (1937).] AUTHORS.

1358. Glow-Discharge Electrolysis. Part X. A. Klemenc. *Zeits. f. phys. Chem.* 183. *Abt.A.* 4. *pp.* 297–317, 1939.—Continuing previous work [see Abstract 814 (1939)] an account is given of experiments on glow-discharge electrolysis using a.c., both electrodes being in the gas space. Polar effects are greatly reduced. With dilute H_2SO_4 the same chemical reactions occur as with d.c. Oscillograms are recorded and it is found that the yield per coulomb is slightly less for a.c. than for d.c. owing to the polar oxidation in the latter case. As expected, the electrolysis of solutions of $KHSO_4$ in dilute H_2SO_4 gives very high oxidation yields. L. A. W.

1359. Hittorf Transference Numbers of Sodium and Ammonium Acetates in Anhydrous Acetic Acid. W. C. Lanning and A. W. Davidson. *Am. Chem. Soc., J.* 61. *pp.* 147–150, *Jan.*, 1939.—Kation transference numbers for solutions of ammonium acetate in anhydrous acetic acid have been determined by the Hittorf method at various concentrations between 0·16 and 2·4 molal, and have been found to vary from 0·49 to 0·449 over this range. Similar determinations have been made for sodium acetate at concentrations between 0·3 and 0·9 molal, and the transference numbers have been found to vary from 0·48 to 0·41. The possibility of interpreting the data in terms of the hypothesis of triple ion formation is discussed. It is pointed out that transference numbers obtained for such solutions by the moving boundary and the Hittorf methods are in substantial agreement. AUTHORS.

***1360. Recent Work on Glass Electrodes. L. Kratz.** *Kolloid Zeits.* 86. *pp.* 51–54, *Jan.*, 1939.—New forms of glass electrodes, suitable for pH determination and for potentiometric titrations are described. F. J. B.

1361. Free Energy of Hydration of Gaseous Ions, and Absolute Potential of Normal Calomel Electrode. W. M. Latimer, K. S. Pitzer and C. M. Slansky. *J. Chem. Phys.* 7. *pp.* 108–111, *Feb.*, 1939.—The free energies of hydration of the alkali and halide ions are found to agree reasonably well with the simple expression of Born ($-\Delta F = (1 - 1/D)Ne^2/2r_e$) for solution of charged spheres in a dielectric medium, provided the crystal radii are suitably modified so as to correspond to the radii of the cavities in the dielectric medium. The results show that the dielectric constant of water remains large even in the intense field next to the ion. The entropies of hydration are also found to be consistent with

these radii. Because of the simplicity of this calculation, the resulting free energies of solution of individual ions are considered to be *a priori* the most probable and are used to calculate a value of $-0{\cdot}50$ volt for the absolute potential of the calomel half-cell. AUTHORS.

1362. Kinetic Treatment of Electrolytic Dissociation Equilibrium. G. M. Schwab. *Zeits. f. phys. Chem.* 183. *Abt.A.* 4. *pp.* 250–254, 1939.—The conditions of electrolytic dissociation equilibria are compared with the absolute velocities of the forward and reverse reactions, on the basis of kinetic premises. The most probable assumption is shown to be that the two reactions proceed through an intermediate condition of a quasi-molecule of high energy. This molecule is assumed to be a partly dehydrated ion pair. F. J. B.

See also Abstract 1350.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

1363. Validity of X-Ray Crystal Methods of Determining the Electronic Charge. V. L. Bollman and J. W. M. DuMond. *Phys. Rev.* 54. *pp.* 1005–1010, *Dec.* 15, 1938.—X-ray crystal methods of determining e are criticised mainly on grounds that Bragg reflection determines the lattice dimensions in only a very shallow surface region whereas density measurements are made on a much larger volume of crystal. In extending previous work [see Abstract 5277 (1936)] two thin crystal slabs have been studied. Each is etched with HCl heavily over one face and over half of its opposite face. The upper half of the spectral lines selectively reflected to the photographic plate had thus traversed a slab etched on both sides, the lower half a slab etched on one side. It is shown that the enhanced Laue reflection from regions near the surface is completely suppressed by further etching, and that fainter reflection can then be definitely observed from the interior regions of the crystal. These results are obtained with the crystal on the side of the slit nearest the photographic plate. With the crystal on the opposite side of the slit it is possible to compare very accurately on the same photographic plate the reflection angles for the enhanced surface reflection with the reflection angles for the interior planes. These angles turn out to be precisely equal, thus establishing the validity of the precise determinations of e by Bragg reflection from the surface of macroscopic pieces of calcite. C. J. B. C.

1364. Classical Point Charge. H. J. Groenewold. *Physica*, 6. *pp.* 115–128, *Feb.*, 1939. *In English.*—A modification of the electromagnetic field is examined, serving only as a calculation model for a point charge. AUTHOR.

1365. Proper Energy of the Electron. A. Mercier. *Helv. Phys. Acta*, 12. 1. *pp.* 55–75, 1939. *In French.*—The proper electrodynamic energy of the electron, arising from the possibility of exchange of motion between the electron and the field of variation of the radiation, is calculated by the Born method to a term giving a divergent second approximation expression containing the factor 1/137. In an attempt to overcome this divergence the order of magnitude of each approximation is calculated, taking $\sqrt{1/137}$ as parameter in the series development. Computations are also made for the case of a free electron and for that of the Dirac theory of " holes," and the results of these investigations are critically discussed. N. M. B.

1366. Evidence for the Existence of a New Elementary Particle. E. E. Witmer and M. A. Pomerantz. *J. of Applied Physics*, 9. *pp.* 746–753, *Dec.*, 1938.—Recent cosmic-ray research has indicated the possibility of the existence of another elementary particle which has the same charge, either positive or negative, as the electron but a larger mass. The main methods of cosmic-ray investigation are by means of ionisation chambers, Geiger counters and Wilson cloud chambers. The latter method has the advantage of giving precise knowledge about individual particles while the first two afford statistical information. The evidence is therefore considered under two heads, direct and statistical. From a detailed analysis of the two sets of data it is concluded that such a particle, the barytron, does exist, and that it has an electronic charge and a mass between those of electron and proton. Results point to a rest-mass of some hundred times that of the electron. Some investigators suggest that the rest-mass may not be unique and even postulate quantum transitions therein. C. J. B. C.

1367. Equations of Motion of a Charged Corpuscle in the Presence of Magnetic N-Poles with Preferred Axes. C. Agostinelli. *Accad. Lincei, Atti*, 28. *pp.* 88–92, *Aug.*, 1938.—The motion of a charged particle in the presence of magnetic N-poles with preferred axes is considered and the first integrals of the equations of motion are discussed. [See following Abstract.] C. J. B. C.

1368. Motion of a Charged Corpuscle in the Presence of a Magnetic Dipole. C. Agostinelli. *Accad. Lincei, Atti*, 28. *pp.* 183–193, *Oct.*, 1938.—The problem of the motion of a charged particle in the presence of a magnetic dipole, which is of importance in connection with the theory of the aurora borealis, has been treated in a previous communication [see Abstract 4224 (1938)]. The present note deals with the integration of the Jacobian equation which occurs in the treatment. [See preceding Abstract.] C. J. B. C.

1369. Emission and Absorption of Heavy Electrons. H. S. W. Massey and H. C. Corben. *Cambridge Phil. Soc., Proc.* 35. *pp.* 84–94, *Jan.*, 1939.—The quantum theory of the heavy electron field is applied to calculate approximately the cross-sections for "photoelectric" absorption of heavy electrons by a bound nuclear particle and for emission of a heavy electron by a free nuclear particle on collision with a nucleus. The absorption cross-section per nuclear particle is of the order 10^{-26} cm^2. for heavy electrons with energies up to 10^8 eV, but probably decreases rapidly at higher energies. Although the energy loss of a proton, of energy 10^8 eV or higher, due to heavy electron emission is found to be greater than that due to radiation, the cross-section is very small ($\sim 10^{-29}$ cm^2.) and the phenomenon is unlikely to be observed in a cloud chamber. In the present state of theory it is impossible to decide whether radiative emission of heavy electrons by nuclear particles is capable of contributing appreciably to the heavy electrons observed at sea-level, but, if so, the cross-section for the process must be very much greater at high energies than in the non-relativistic energy region which the authors have investigated. AUTHORS.

1370. Nuclear Collisions. L. Goldstein. *J. de Physique et le Radium*, 10. *pp.* 23–29, *Jan.*, 1939.—It is shown that from a statistical point of view the phenomenon of intranuclear transfer is responsible for the formation of an intermediate active nucleus apart from the initially bombarded and bombarding particles. The formation of this inter-

mediate nucleus is presented as a sort of transition of the system, initially in a state of unstable equilibrium from a thermodynamical viewpoint, towards a state of stable equilibrium. In an approximate and indirect manner the coefficients of transfer of momentum and energy are evaluated using the model of a gas of neutrons and protons. By means of these coefficients a definition is obtained of the average life or probability of transition of these unstable states. It is shown that the model of an intranuclear gas gives a lower limit for these average lives. It is seen finally that this mechanism of the phenomenon of transfer of energy and momentum gives a useful and descriptive approximation of the mode of formation of intermediate nuclei. G. O. B.

1371. Electron Interference. P. P. Debye. *Phys. Zeits.* 40. *p.* 60, *Jan.* 15, 1939.—This is a method to improve the photographs obtained by the diffraction of electron beams in gas jets. Ordinarily the factor $1/s^4$, where s is twice the size of the angle of deflection, plays an important part by causing intense blackening near to the primary beam, thus hiding the true interference lines. This factor can be eliminated by having a sector rotating in front of the plate so that the time of exposure varies as r^4, where r is the distance from the centre. A diagram is given showing the great improvement in photographs obtained from CCl_4 jets. It ought also to be possible to make visible the reflections and thus the molecular positions of light atoms, especially H atoms. G. G.

1372. Single Scattering of Elementary Particles by Matter. F. C. Champion. *Phys. Soc., Reports,* 5. *pp.* 348–360, 1938.

1373. Anomalous Scattering of Neutrons by He. H. Staub and W. E. Stephens. *Phys. Rev.* 55. *pp.* 131–139, *Jan.* 15, 1939.—The ratio of the cross-sections for elastic backward scattering of neutrons in He and H_2 has been measured as a function of the neutron energy. This ratio is practically constant between 2 and 6 eMV neutron energy and has a value of about 1·3. However, at 1 eMV, the ratio increases to about nine. This anomaly must be caused by resonance scattering occurring from the formation of an unstable compound nucleus He^5. Theoretical considerations show that the level of He^5 involved must be a p level. AUTHORS.

1374. Capture of Neutrons by Atoms in a Crystal. W. E. Lamb, Jr. *Phys. Rev.* 55. *pp.* 190–197, *Jan.* 15, 1939.—The precise determination of the properties of nuclear resonance levels from the capture of slow neutrons is made difficult by the fact that most of the substances used for absorbers and detectors are in the solid state, so that the calculations of Bethe and Placzek [see Abstract 2307 (1937)] for the influence of the Doppler effect are inapplicable, since these were based on the assumption of a perfect gas. In this paper, their calculations are generalised to include the effect of the lattice binding. Under the assumption that the crystal may be treated as a Debye continuum, it is shown that for sufficiently weak lattice binding, the absorption curve has the same form as it would in a gas, not at the temperature T of the crystal, however, but at a temperature which corresponds to the average energy per vibrational degree of freedom of the lattice (including zero-point energy). In cases of somewhat stronger lattice binding, the line form is found to be more complicated, and may even have a fine structure. Plots are given of the absorption line in several typical cases. An approximate formula for the cross-section for self-indication is also derived. AUTHOR.

***1375. Apparatus for Electron Diffraction at High Temperatures. R. Jackson and A. G. Quarrell.** *Phys. Soc., Proc.* 51. *pp.* 237–243, *March*, 1939.—Apparatus and technique are described by means of which the examination of surfaces by electron-diffraction may be carried out at temperatures up to 1200° C. The diffraction section is water-cooled, and a special feature of the design is that no refractory material is used in the vacuum chamber; this enables a high vacuum to be maintained.

AUTHORS.

1376. Secondary Electron Emission. R. Kollath. *Zeits. f. techn. Physik*, 19. 12. *pp.* 602–604, 1938.—A description is given of an oscillographic apparatus used in the investigation of secondary electron emission from a bombarded kathode; the complete curve of output against primary electron voltage is visible on the screen and its variations can be followed. Particular applications described are its use in investigating the diminution of the secondary emission from a Ni surface when Be is evaporated on it, and the influence of temperature on the emission from such a composite surface. D. H. F.

***1377. Television Optics. W. D. Wright.** *Phys. Soc., Reports*, 5. *pp.* 201–209, 1938.

1378. Image Formation in the Electron Ultra-Microscope. B. v. Borries and E. Ruska. *Zeits. f. techn. Physik*, 19. 11. *pp.* 402–407, 1938.—According to the published theory of the Siemens electron microscope, the variations in image brightness are explained as a simple consequence of the differential scattering of electrons due to different thickness or density of the object. This simple theory is not correct and would require a much lower resolving power than is actually attained. A more accurate theory of image formation is advanced according to which only a part of the electron beam is scattered by the object, the remainder continuing undeviated; the ratio of the scattered to undeviated current increases with object density or thickness and the image is formed by focusing of the undeviated beam. The correctness of this revised theory is demonstrated experimentally. Some microphotographs exemplifying the highest resolution attainable to date with the ultra-microscope are reproduced.

J. E. K.

***1379. Electron-Scan Microscope. M. v. Ardenne.** *Zeits. f. techn. Physik*, 19. 11. *pp.* 407–416, 1938.—The theory of the electron-scan microscope (*Rastermikroskop*) has been given in a previous paper [see Abstract 4228 (1938)]; in this paper details of the practical construction and operation of an electron-scan microscope with photographic registration are presented. The description covers: (*a*) the method of producing the fine electron probe and deflecting it over the object, (*b*) the photographic recorder, (*c*) the method used to determine the adjustments necessary to give the maximum sharpness of image, (*d*) a new device for maintaining correct adjustment during the whole recording time. Examples of pictures obtained with the instrument are reproduced; they show that an electron probe diameter of 10^{-5} mm. is attainable in practice. J. E. K.

***1380. Kathode-Ray Tubes and their Applications. E. S. L. Beale.** *Journ. Sci. Instruments*, 16. *pp.* 53–58, *Feb.*, 1939.—A review of exhibits at the Physical Society's Exhibition, 1939.

See also Abstracts 976, 1100, 1123, 1124, 1152, 1311.

ELECTROSTATICS.

***1381. Axial Field in H.V. Generator Tube-Support. J. Virgitti.** *Comptes Rendus*, 207. *pp.* 1085–1088, *Dec.* 5, 1938.—The field along the axis of the tube support of a H.V. generator which has a spherical collector is calculated. It is a maximum in the neighbourhood of the sphere. Two methods are suggested which will permit the collector to reach its optimum potential in air; the easier method involves placing the collector in an equipotential field. H. J. H. S.

***1382. Powerful H.V. Generator. A. Raskin.** *Comptes Rendus*, 208. *pp.* 170–172, *Jan.* 16, 1939.—Additional modifications to a generator previously described [see Abstract 3842 (1938)] have raised the output to 800 mA. N. M. B.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

1383. Hall Effect in Pure Metals at Low Temperatures. M. Kohler. *Ann. d. Physik*, 34. 1. *pp.* 23–28, *Jan.*, 1939.—Under certain assumptions the theoretical distribution of the electrons in a metal subjected to electric and magnetic fields is determined. It is found that the Hall constant for temperatures lower than the characteristic temperature should have the same value as for higher temperatures. The Hall coefficient found from the theory agrees approximately with known experimental values. G. E. A.

1384. Thermomagnetic Properties of Cubic Ferric Oxide. G. Chaudron and A. Michel. *Comptes Rendus*, 208. *pp.* 90–92, *Jan.* 9, 1939.—It is possible to identify the rhombohedral and cubic forms of Fe_2O_3 by thermomagnetic analysis. The former is stable, weakly ferromagnetic, and has a Curie point at 675°. The latter is unstable and strongly ferromagnetic. The cubic form can be stabilised by the replacement of FeO groups by alkali oxide groups, such as Na_2O. All such stabilised solid solutions are strongly ferromagnetic and have a cubic structure. The magnetic properties of forms of Fe_2O_3 obtained by dehydration of FeO.OH are discussed. The difference in the magnetic properties of the pyrrhotins (solid solutions of S in FeS) are also considered. These substances exist in two states, one ferromagnetic, the other paramagnetic, but both give the same Debye-Scherrer diagrams. Nevertheless, the difference is probably due to some important difference in crystalline structure, possibly in the state of ionisation of the constituent atoms, or the position of additional S atoms in the FeS lattice. A. J. M.

MAGNETISM AND ELECTROMAGNETISM.

1385. Partition Displacements between Weiss Domains. M. Kersten. *Zeits. f. techn. Physik*, 19. 12. *pp.* 546–551, 1938.—From measurements on the rectangular hysteresis loops of Fe-Ni alloys (60% Ni, 40% Fe) in the form of wire in tension for different degrees of internal strain, the initial susceptibility and critical field strength are deduced. These quantities are then used to calculate the number of electrons in a completed shell of the domain partition. H. J. H. S.

1386. Collective Electron Ferromagnetism. Part II. Energy and Specific Heat. E. C. Stoner. *Roy. Soc., Proc.* 169*A*. *pp.* 339–370, *Feb.* 7, 1939.—The treatment of collective electron ferromagnetism,

based on Fermi-Dirac statistics, applied in a previous paper to magnetic characteristics [see Abstract 2167 (1938)], is extended to the discussion of energy characteristics. The theory is developed for electrons in a standard form of energy band, subject to interaction effects giving rise to a dependence of energy on the square of the magnetisation. The electronic energy can be analysed into a quasi-magnetic and a distributional part; forms of these in the classical and Fermi-Dirac limits are obtained. General expressions are derived for the specific heat at low temperatures and at the Curie point. Detailed computations are made of the energy and specific heat over the whole temperature range for $\epsilon_0/K\theta^1 \to O$, and for $K\theta^1/\epsilon_0 = 2^{-1/2}$, where $K\theta^1$ is a measure of the maximum quasi-magnetic interaction per electron, and ϵ_0 is a distributive parameter; critical values for complete saturation at absolute zero are tabulated. The limiting low temperature ratio of specific heat to temperature depends only on the distribution at absolute zero. A preliminary survey of specific heat results for Ni is made; the general character of the results is in good accord with the theory. J. S. G. T.

1387. Partition Energy for Large Barkhausen Discontinuities. W. Döring and H. Haake. *Zeits. f. techn. Physik*, 19. 12. *pp.* 551–554, 1938.—In 1932 Bloch derived theoretically the value of the partition energy of a Weiss domain. Experimental results are now quoted which are in agreement with the theoretical values. H. J. H. S.

1388. Decomposition of Elementary Moment of Ferromagnetic Substances and Gyromagnetic Phenomena. R. Forrer. *Comptes Rendus*, 207. *pp.* 1390–1391, *Dec.* 27, 1938.—From the values of the spin moment μ_s and the orbital moment μ_o which together give the total magnetic moment of the molecule [see Abstract 843 (1939)], the high limit of the gyromagnetic ratio has been calculated for 7 ferromagnetic elements and alloys. No recorded value is greater than the corresponding calculated high limit. [See following Abstract.] W. R. A.

1389. Curie Point, Orbital Moment and Crystal Net. R. Forrer. *Comptes Rendus*, 208. *pp.* 175–177, *Jan.* 16, 1939.—The view that the elementary magnetic moment of an alloy consists of two parts, a "base" portion due to spin, and a supplementary portion due to the orbit, is supported by the fact that in all Co-Ni and Fe-Ni alloys (both having a cubic face-centred lattice) the Curie point depends only on the supplementary moment, being independent of that due to spin. [See preceding Abstract.] C. A. S.

***1390. New Method of Measuring Intensities of Magnetisation. B. H. Schultz.** *K. Onnes Lab., Leiden, Comm. No.* 253*d*. *Physica*, 6. *pp.* 137–144, *Feb.*, 1939. *In English.*—In view of the recent results about ferromagnetic properties of some salts at low temperatures, the author has developed a new method for measuring magnetisations, which is especially suitable for field-dependent susceptibilities and permits measurements in constant, low and homogeneous fields. A full description is given of method and apparatus together with results on ferric-alum, which served as a calibration for the absolute values. AUTHOR.

1391. X-Ray Examination of Orientation of Electron Orbits in Pyrrhotite by Magnetisation. R. E. Stephens. *Univ. of Pittsburgh, Bull.* 35. *pp.* 277–283, *Oct.* 1, 1938.—The change of X-ray reflection by crystals of pyrrhotite ($FeS + S_x$) caused by magnetisation is very small and accordingly unequivocal evidence of the possible contribution to

magnetic behaviour by orbital motions of electrons cannot be obtained by this method. W. R. A.

1392. Effect of Water on Magnetic Constants of Rare Earths. B. Cabrera. *Comptes Rendus*, 207 *pp.* 1077–1080, *Dec.* 5, 1938.—The main cause of error in determining the true value of the susceptibility in rare-earths is the presence of water. This has been made evident by a study of different salts obtained from different sources. Examples show, further, that the magnetic constant for the kation is smaller in the oxides than in the sulphates. The Curie constant, found after removal of water from the salt, is in better accordance with the theoretical value. G. E. A.

1393. Anomalies in Magnetisation of Anhydrous Salts of Iron Group. W. J. de Haas and B. H. Schultz. *J. de Physique et le Radium*, 10. *pp.* 7–9, *Jan.*, 1939.—The susceptibility of $CoCl_2$ was measured at low temperatures. At liquid-H_2 temperatures the remanent magnetism is very feeble, but when the substance is cooled in a magnetic field the remanence is much greater. At 20° K. the susceptibility is constant for $H < 800$ G; for fields greater than 800, it increases, becoming constant for $H > 20{,}000$. The saturation point is not reached for $H = 29{,}000$ at 14° K. G. E. A.

1394. Metamagnetism. J. Becquerel and J. van den Handel. *J. de Physique et le Radium*, 10. *pp.* 10–13, *Jan.*, 1939.—In measuring the magnetic rotatory power of mesitite (carbonate of Fe and Mg), it was found that this mineral had, at low temperatures, properties of hysteresis and remanence resembling those of ferromagnetic bodies, but with certain outstanding differences. In fields greater than 30,000 and at 1·5° K. there is no sign of an approach to saturation; the coercive force is 2000, and hysteresis only becomes evident when the field exceeds several thousand gauss. It is not certain whether this is a new aspect of ferromagnetism or something quite different. Meantime the authors suggest for it the name metamagnetism. G. E. A.

1395. Magnetic Behaviour of Vanadium, Titanium and Chrome Alum. J. H. van Vleck. *J. Chem. Phys.* 7. *pp.* 61–71, *Jan.*, 1939.—The susceptibilities of both Ti and V alum conform to the "spin-only" formula, and this requires that the ratio of the fourth to the second order part of the non-cubic portion of the crystalline potential have a certain critical value. The present paper investigates whether such a ratio can result from (1) the direct effect of the atoms more remote than the 6 H_2O molecules surrounding the paramagnetic ion, (2) the indirect action of the remote atoms in distorting the water cluster from the octohedral shape, or (3) the Jahn-Teller effect. It is concluded that neither (1) nor (3) can be alone effective, but that the total splitting is materially amplified by the superposition of (3) on (2). [See following Abstract.] G. E. A.

1396. Jahn-Teller Effect and Crystalline Stark Splitting for Clusters of the Form XY_6. J. H. van Vleck. *J. Chem. Phys.* 7. *pp.* 72–84, *Jan.*, 1939.—The paper develops the theory needed in connection with the preceding paper [see preceding Abstract]. The normal theory for a molecular cluster such as $X \cdot 6H_2O$ (X = Ti, V, Cr) is materially different from usual if the X ion is degenerate (see Abstract 221 (1938)]. Stability is achieved only if the water group is distorted from the cubical arrangement. A calculation is made of the magnitude of the effect which has an important bearing on magnetic behaviour. The cluster $X \cdot 6H_2O$ is not treated as free, but as embedded in a trigonal field of force, and the Stark splittings are obtained as a corollary. G. E. A.

1397. Magnetic Susceptibility of KBr Crystals with Colour Centres. P. Jensen. *Ann. d. Physik*, 34. 2. *pp.* 161–177, *Jan.*, 1939.—An alkali-halide crystal with colour centres contains more metal than halogen ions. The magnetic susceptibility of normal and coloured crystals was measured to gain further knowledge how the stoichometric surplus metal ions and the appertaining electrons are arranged. It was found that the volume susceptibility of a KBr crystal with N colour centres per cm^3. is at room-temperature about $2 \cdot 6 \times 10^{-27}$ N greater than that of the same crystal in the uncoloured condition. This holds for optically measured concentrations in the range 1×10^{17} to 6×10^{17} centres per cm^3. The molecular susceptibility of the colour centre gas in the concentration range mentioned and at room-temperature is accordingly $1 \cdot 58 \times 10^{-3}$, and the effective moment of a centre under the same conditions is 1·93 Bohr magnetons. J. J. S.

1398. Ortho-Para Conversion of Hydrogen in Diamagnetic Liquids. L. Farkas and L. Sandler. *Faraday Soc., Trans.* 35. *pp.* 337–342, *Feb.*, 1939.—The rate of the *ortho-para* conversion of H_2 and D_2 in liquid H_2O, D_2O, C_6H_6, CS_2 and CCl_4 has been accurately determined. The conversion is caused by some induced magnetic moments acting in all liquids, which are superposed by the action of the nuclear paramagnetism in hydrogen compounds. With *o*-D_2 there is possibly a new type of conversion ; an *ortho-para* transition can take place in consequence of an interaction between the electric quadrupole, representing the D_2 molecule, and molecular inhomgeneous electric fields. The electric quadrupole of the D_2 molecule arises from the electric dissymmetry of the D nucleus. Authors.

1399. Paramagnetism of Cupric Salts of Linear Chain Fatty Acids. J. Amiel. *Comptes Rendus*, 207. *pp.* 1097–1100, *Dec.* 5, 1938.—New measurements of the paramagnetism of the cupric salts of 14 linear chain fatty acids are found to give a value of approximately 7 Weiss magnetons for the Cu atom instead of the accepted value 10 for the ion Cu^{++}. This result is at variance with that of Bhatnagar, Singh and Ghani who found values of 9 to 10 magnetons for the Cu atom in salts of this kind. W. S. S.

1400. Paramagnetic Dispersion and Absorption. C. J. Gorter. *Zeits. f. techn. Physik*, 19. 12. *pp.* 501–509, 1938.—An investigation of paramagnetic dispersion in a constant parallel magnetic field. In the temperature region of liquid air, dispersion appears with frequencies of about $10^6 \sim$. The course of the dispersion in chrome and iron alums is flatter than required for a simple Debye curve. A method is described for measuring paramagnetic absorption, and the results for a number of substances give very short times of relaxation which are independent of the temperature. With a constant field of 10^3 Oe., the absorption in iron alum increases strongly and follows the course of a Debye function. The dispersion can be expressed as the sum of a Debye function corresponding to the absorption curve and a function of the field strength independent of the frequency. A theoretical discussion is given. [See Abstract 1303 (1939).] G. E. A.

1401. Residual Paramagnetism in Compounds of Lanthanum. R. B. Haller and P. W. Selwood. *Am. Chem. Soc., J.* 61. *pp*, 85–88, *Jan.*, 1939.—Accurate measurements of magnetic susceptibility at 20 and − 150° have been made on the compounds $La_2(SO_4)_3 \cdot 9H_2O$, $La_2(C_2O_4)_3 \cdot 10 H_2O$, and La_2O_3, the last-named being prepared in two different ways.

A slight residual paramagnetism was observed in all cases. The possible causes of this phenomenon are examined. It is suggested that this work constitutes direct observation of the so-called " surface " paramagnetism which has been postulated to explain the small ortho-para hydrogen conversion on supposedly diamagnetic surfaces. AUTHORS.

1402. Mutual Inductance and Force between Two Coaxial Helical Wires. C. Snow. *Bureau of Standards, J. of Research*, 22. *pp.* 239–269, *Feb.*, 1939.—A formula is found for the mutual inductance and force between two coaxial helical wires which, in addition to the well-known current-sheet formula, contains small correction terms. One of these represents the axial components of current; one the finite diameters of the wires; and another ω_a, which depends upon the relative azimuths of the helices, arises, naturally, from the actual helical form of the windings. The pitch of the windings may be different in the two, but each is considered so small in comparison with the cylindrical radii that terms relatively smaller than the square of this ratio may be neglected. The number of turns is not necessarily an integer. AUTHOR.

See also Abstracts 894, 929, 1268, 1349.

MEDICAL RADIOLOGY AND ELECTROLOGY.

1403. Nerve Conduction with Distributed Capacitance. A. M. Weinberg. *J. of Applied Physics*, 10. *pp.* 128–134, *Feb.*, 1939.—Rashevsky's theory of nerve conduction [see Abstract 4687 (1933)] has been extended to include the effects of distributed capacitance along the fibre. The simple theory of Rashevsky, based on the idea of local re-excitation by bioelectric currents according to Blair's law of excitation, leads to a formula for the initial velocity of the nerve impulse: $v = ak/\log A_0/(A_0 - \mathfrak{R})$, where a is the distance between Ranvier nodes, k is related to the chronaxie of the nerve, A_0 is the local exciting current, and $\mathfrak{R}$ is the threshold for excitation. This result does not depend explicitly on G, the node leakance. The present analysis gives for the initial velocity, in case $G/C \gg k$, $v = ak/\log A_0/\{A_0 - (\mathfrak{R} + A_0\psi)\}$, where ψ is a complicated function of C and vanishes when $C = 0$. In case G/C is not $\gg k$, the velocity is given as the root of a transcendental equation which may be solved graphically. Formulæ for the asymptotic velocity of propagation are similarly related in Rashevsky's and the present case. Empirical data necessary to check the validity of these results are as yet unavailable; the type of experiment needed to obtain these data is suggested. AUTHOR.

1404. Biophysical Basis of Ultrashort-Wave Therapy. B. Rajewsky. *Radiology*, 31. *pp.* 697–706, *Dec.*, 1938.—An analysis of the relative values of conduction and displacement currents during the passage of h.f. currents through multiple layers of semiconductors of different resistance and dielectric constant, shows that the formula of Paetzold for selective heating has only a very limited application. Systematic measurements of conductivity and dielectric constants of biological materials have been made, and it is found that, in general, any selective heating effect, even for very different conductivity values in multiple layers, is very small. All factors seem to indicate the advisability of using the shortest possible wave-length, at least down to 3 m. When, however, the microscopic structure of tissues is considered, it is shown that there is a very marked wave-length dependence of the reactions produced,

owing to the peculiarities, from a conductivity point of view, of the internal cellular arrangements. It is suggested that h.f. currents may have some diagnostic value in the recognition of pathological changes in cell structure. J. E. R.

1405. Localisation of Foreign Bodies. E. K. Reid and L. F. Black. *Radiology*, 31. *pp.* 567–583, *Nov.*, 1938.—This paper, which emanates from the Army Medical School, U.S.A., deals with the localisation of foreign bodies from the point of view of its military importance. An extensive review of the literature and the methods employed and recommended by various writers is given. Since the Strohl double-tube shift two-wire method is the only method to survive the elimination process of instruction of the U.S. Army it is fully described. The single-tube shift method with triangulation is also described. Recommendations and general conditions for good work in localising foreign bodies radiographically are given. Minor matters—skin marking, reports, and the localising profundoscope—are mentioned. G. G.

1406. X-Ray Kinematography of Internal Organs and Circulation of Blood. K. Kawaishi. *Am. J. of Roentgenology and Radium Therapy*, 40. *pp.* 913–921, *Dec.*, 1938.—The author describes practical details of X-ray kinematography of the internal organs of human beings and animals, particularly in respect to the best type of fluorescent screen, the best X-ray intensity, voltage and dosage, distances between the tube, screen and camera lens, most suitable photographic films as determined by spectrographic methods and practical experience, maximum speed of individual exposures for different organs and duration of exposures without danger to the subject. Simultaneous records (movietones) of the heart and lung sounds have also been made. B. J. L.

1407. Therapeutic Effects of Radiation. W. Friedrich. *Zeits. f. techn. Physik*, 19. 11. *pp.* 372–376, 1938.—A general discussion of the problems involved in the application of radiation, visible, u.v. and infra-red to the human organism in health and disease. The effect of radiation may be direct (*e.g.*, the production of local heating, stimulation of the blood-flow, erythema, etc.), or, more frequently, it may be secondary, especially in the case of the u.v. This affects a number of biological actions of which the best known is that involving the minerals Ca and P in the prevention of rickets. Many others are enumerated by the author, who points out that the subject is still at a very empirical stage. J. W. T. W.

1408. Radiation Therapy. W. Schultze. *Zeits. f. techn. Physik*, 19. 11. *pp.* 376–381, 1938.—Light therapy may be carried out with sunlight or one of the various artificial sources such as the carbon arc, the quartz-Hg-lamp, the quartz-Cd-lamp, or one of the special filament lamps. It is applied in the case of many different diseases, including skin diseases such as eczema, and the very important class of tubercular affections. The author gives a brief description, summarised in a table which indicates in general terms the suitability of radiation from each of the artificial sources mentioned to the treatment of 19 different diseases. The precautions to be observed, particularly avoidance of over-dosage, are mentioned. J. W. T. W.

1409. Dosage in Light Therapy. R. Schulze. *Zeits. f. techn. Physik*, 19. 11. *pp.* 381–386, 1938.—Describes the difficulties met with in devising a system of measurement of u.v. energy which will be suitable for determining dosage in the various branches of light therapy. One system which has been much used is the measurement of the energy in

three regions, *viz.* 400–313–280–200 mμ. Alternatively, a determination of the spectral energy distribution must be made, the intensity at each wave-length region being then weighted according to the relative effectiveness of light of that wave-length for producing the action under consideration. J. W. T. W.

1410. Bioclimatic Effects of Solar Radiation. H. Pfleiderer. *Zeits. f. techn. Physik*, 19. 11. *pp.* 386–389, 1938.—The meteorological conditions which affect the amount of therapeutically important radiation are considered. The chief difficulty in the subject is that of knowing the relative effectiveness of the different parts of the spectrum, especially in the u.v. The heating effect of the solar radiation necessary for curative purposes makes it important to study the cooling power of the atmosphere under different meteorological conditions. J. W. T. W.

1411. Biological Effect of Light Quanta. P. Jordan. *Zeits. f. techn. Physik*, 19. 11. *pp.* 389–391, 1938. *Phys. Zeits.* 39. *pp.* 951–953, *Dec.* 15, 1938.—A cell of B. coli can be killed by the absorption of a single quantum of u.v. radiation. Experiments with ionising radiation have made it possible to study the active-centre of the cell and the effect upon it of u.v. absorption. J. W. T. W.

1412. Effect of Radiation on Eggs of Drosophila. K. Sommermeyer. *Zeits. f. techn. Physik*, 19. 11. *pp.* 391–394, 1938. *Phys. Zeits.* 39. *pp.* 953–956, *Dec.* 15, 1938.—The lethal effect of u.v. radiation and X-rays on the eggs of *Drosophila* are compared. It is found that the effect of u.v. is only slightly affected by the age of the egg while in the case of X-rays the effect is very dependent on the age. The wave-length of the u.v. radiation (so long as it is less than 365 mμ) is not important. The curve connecting effect with dosage is very different for the two forms of radiation. J. W. T. W.

***1413. Simple Xenon Lamp to Produce Short-Wave U.V. Radiation. M. v. Ardenne.** *Zeits. f. techn. Physik*, 20. 1. *pp.* 30–31, 1939.—The construction and properties of a xenon lamp, in constant connection to a vacuum pump and having a quartz glass window to produce short-wave u.v. light is described together with a diagram and photographic illustrations. With an input of 150 W, about 10^{16} quanta of wave-lengths 1295 and 1469 Å, pass through the used quartz glass window. The quality of the radiation is independent of the time of operation and total use. B. J. L.

***1414. Operation and Characteristics of Quartz-Mercury-Vapour Lamps for U.V. Irradiation. G. N. Peel.** *Brit. J. of Radiology*, 12. *pp.* 99–120, *Feb.*, 1939.—The paper is intended chiefly as a guide to the operation and performance of the principal types of quartz-mercury-vapour lamps used for medical and technical purposes. The fundamental phenomena and the radiation characteristics of the various lamps are discussed, and wave-length-intensity data of typical lamps are tabulated. The author describes experiments showing that lamps of the low-pressure discharge type have a definite starting phase, hitherto unobserved, which he attributes to the partial reversal of the 2536·5 Å resonance radiation. By artificial control of the ambient temperature it is possible so to control this reversal, in the case of one type of lamp, that the intensity of radiation is almost doubled when the lamp is operated somewhat below its normal temperature. Practical implications of the starting phase in both high- and low-pressure lamps are considered, and the importance of operating the lamps under standard conditions of temperature and voltage is stressed.

The isolation of Hg wave-lengths by monochromators and filters is briefly described, and reference is made to a new form of transparent and translucent fused silica, known as Stannosil, which does not transmit below 2800 Å in the u.v. The inverse square law of illumination is shown to be applicable, within certain limits, to Hg lamps, although they are not point sources. AUTHOR.

1415. Biological Measurement of Radiation Quantities. P. S. Henshaw and D. S. Francis. *Am. J. of Roentgenology and Radium Therapy*, 40. *pp.* 906–912, *Dec.*, 1938.—Various biological reactions have been utilised to measure X- and γ-rays. There would be practical advantages if a single reaction could be utilised to measure the scale of radiation of therapeutic value from l.v. X-rays to the hardest γ-rays. The authors have for this purpose tested various seedlings, eggs of insects, bacteria, yeast and mouse tumours. The present experiments relate to experiments with triticum and lycopersicum seeds, in respect to X-rays produced at 30, 200 and 650 kV and γ-rays from a 4 gm. radium pack, these tests being described in detail. The seeds of lycopersicum have been found to be more affected by higher energy radiations than seeds of triticum. They conclude that solution of the suggested unification of measurement is problematical and that the tedious and difficult tasks of selecting the best therapeutic quality of radiation, in respect to the relative susceptibility of various normal and tumour cells is necessary and justified. B. J. L.

1416. X-Ray Dosage. C. König. *Phys. Zeits.* 40. *pp.* 46–65, *Jan.* 15, 1939.—This paper describes the investigation of the influence of the nature of the slit in the measurements of *r*, the international unit of X-ray dosage. These investigations deal with secondary radiation from the walls of the slit in the form of diffuse scattering, reflected rays from crystals in the walls of the slit and K and L radiation produced in the slit. The measurements are also influenced by the transparency of the walls of the slit; this was studied both by using conical slits and cylindrical, conical beams and parallel beams. The inclined position giving the so-called "canal effect" was also studied. In these experiments the results agree well with calculations. The conical slit was found to be much more satisfactory than the cylindrical one. Corrections for transparency are given; this correction is smaller the greater the diameter of the slit. G. G.

1417. Use of X-Rays and γ-Rays in Medicine. W. V. Mayneord. *Phys. Soc., Reports*, 5. *pp.* 284–301, 1938.

1418. Influence of Wave-Length on Biological Effectiveness of Radiation. H. G. Crabtree and L. H. Gray. *Brit. J. of Radiology*, 12. *pp.* 39–53, *Jan.*, 1939.—Previous investigations on this subject have given conflicting results and extreme claims of a highly selective action of certain wave-lengths of X-rays and for ultra-short wireless waves have now been discredited. Experiments are now described in which a radiation-sensitive biochemical process is used as a test object. It was found that the same percentage reduction in the anaerobic glycolysis of rats' retina is produced by irradiation at low temperature for the same time with equal intensities of β-, γ- and X-radiation. It is estimated that in the case of β-radiation a difference of 25% would certainly have been detected, and in the case of γ-radiation a difference of 15%. Electromagnetic radiations such as X- or γ-radiation produce their effects on tissue through the ionising action of the secondary electrons that they generate and these secondary electrons differ only in energy from the

natural β-rays of Ra. On this basis it is concluded that, when using $(\beta + \gamma)$ rays from Ra filtered by 0·12 mm. Ag, comprising 95% β-rays and 5% γ-rays, the resulting radiation has an average energy of 450 kV or a quantum energy of 1600 kV. The γ-rays used were filtered through 0·12 mm. Ag + 0·5 mm. Pt + 0·8 mm. brass having a quantum energy of 800 kV while the X-rays were obtained from a tube operated at 200 kV constant potential with additional filtration of 1·5 mm. Cu and had 100 kV quantum energy. The experiments are thus equivalent to a comparison of the biochemical effectiveness of homogeneous radiations of 1600 kV, 800 kV and 100 kV quantum energy or to X-radiation generated by tubes operating at 3 emV, 1·5 emV and 200 kV respectively. T. A. C.

***1419. Beam Direction in X-Ray Therapy. J. L. Dobbie.** *Brit. J. of Radiology*, 12. *pp.* 121–128, *Feb.*, 1939.—Advantages are claimed for the use of small fields in the X-ray treatment of malignancy. Photographic verification of the necessary accuracy of aim is described. This principle has led to the design of appliances with which treatment may be planned, and verified treatment repeated under fixed conditions. These appliances also furnish data for quantitative prescription. The manufacture and use of five such appliances are described. AUTHOR.

1420. Radium Poisoning. B. Rajewsky. *Radiology*, 32. *pp.* 57–86, *Jan.*, 1939.—Since most substances are radioactive to some extent, it was decided to investigate poisoning by the internal application of radioactive substances in which investigation the following points arise :—the retention and elimination of the radioactive substances by the body ; the distribution of the retained material within the body; the tolerance, or toxic dose, of the material ; and therapeutic measures necessary. Two cases of Ra poisoning are described—one lung fibrosis and the other showing bronchial cancer. A special form of counter used in the investigation of radioactive deposits in the body is described. The results obtained in these two cases are compared with those from normal human bodies. A table is also given showing the elimination of Ra by the human body. G. G.

1421. Biology and Atomic Physics. N. Bohr. *N. Cimento*, 15. *pp.* 429–438, *July*, 1938. *In English.*—An address given at the celebration of the bi-centenary of the birth of Luigi Galvani. The ideas expressed are a development of those given in an earlier paper [see Abstract 2651 (1933)]. Before Galvani's discoveries, a whole fundamental aspect of the laws of physics remained hidden. It is most suggestive to think that the germ which in the hands of Volta, Oersted, Faraday and Maxwell developed into a structure rivalling Newtonian mechanics in importance, grew out of researches with biological aim. Tracing in detail the historical development of the modern atomic physics from Faraday's researches on galvanic electrolysis to the quantum mechanics of Heisenberg, the author seeks a correlation between life and free will and atomic phenomena, in the reactions of living organisms, *e.g.*, the sensitivity of visual perception or the induction of gene mutation by penetrating radiation. The existence of life should be considered, both as regards its definition and observation, as a basic postulate of biology, not susceptible of further analysis, in the same way as the existence of the quantum of action, together with the ultimate atomicity of matter, forms the elementary basis of atomic physics. T. A. C.

See also Abstract 1142.

OSCILLATIONS AND WAVES.

1422. Ionised Gas Oscillators in a Magnetic Field. T. V. Ionescu. *Comptes Rendus*, 208. *pp.* 85–88, *Jan.* 9, 1939.—It has previously been shown [see Abstract 4259 (1938)] that if a Ni ring, whose potential exceeds 1000 V, is placed between two Al plates in a magnetic field, h.f. oscillations are produced which depend, among other things, on the secondary emission from the plates. Investigation shows that the mechanism of the oscillations can be satisfactorily explained on the supposition that constant velocity electrons move about in a cylinder of ionised gas whose potential is the same as that of the ring. If the gas pressure is between 8×10^{-3} and 5×10^{-2} mm. Hg. and if the magnetic field is great enough, this constant potential cylinder between the Al plates is very luminous. The positive ions accelerated between the cylinder and the plates strike the plates and produce secondary electrons, which in turn are accelerated between the plates and the ionised cylinder, which they penetrate, being reflected at the other side. At each traverse they lose energy in ionising the gas and finally they are captured by the ring. A. W.

1423. Correlation of Magnetic Activity with Disturbance of Radio Transmission. A. G. McNish and H. F. Johnston. *Terr. Mag.* 43. *pp.* 417–426, *Dec.*, 1938.—The measure of radio-disturbance selected was the transmission-disturbance figure for the h.f. circuits between New York and London, proportional to the average signal-strength depression, each day, below the preceding ten-day average. Two measures of magnetic activity were utilised: (1) the American magnetic character-figure, being the average of assessments by seven American magnetic observatories (although these assessments are subjective they have proved reliable); and (2) the Potsdam magnetic index (Bartels), in which the intensity figure is on a log. scale. Using the former, 0·73, and the latter, 0·67, were the correlation-coefficients obtained for the period 18.12.37 to 18.5.38. The geographical discrepancies between the radio and the magnetic disturbance figures were about the same in the two cases. When the present period of excessive magnetic activity has passed, the 27-day recurrence, previously established for magnetic disturbance, should also be revealed in the behaviour of radio transmission. Plots of the daily values (Jan. 1937 to April, 1938) of the two indices show the same patterns. R. M.

1424. Scattering of Radio Waves in the Ionosphere. T. L. Eckersley. *Nature*, 143. *pp.* 33–34, *Jan.* 6, 1939.—The salient facts of ionospheric scattering are: (1) at frequencies exceeding the critical, a pulse receiver shows characteristic scatter groups (S) of echoes from apparent height 80–300 km.; (2) S echoes are not reflected vertically; (3) the least equivalent height of S depends on the frequency and approaches that of the second-order F_2 vertical reflection as the critical frequency is approached; (4) with a beam transmitter, energy is scattered back along the path of the beam; (5) S disappears when the frequency is so high that the ray tangential to the earth escapes through the F_2-layer. These facts may be explained by assuming that rays penetrate the E-layer obliquely, are reflected from F, and pass again through E. At the two points of penetration of E the rays meet scattering clouds, the further point of penetration accounting for the S echoes. There are no scattering clouds in F. J. P. A.

***1425. Electric Wave Filters. N. F. Astbury.** *Phys. Soc. Reports*, 5. *pp.* 334–347, 1938.

See also Abstracts 1028, 1064, 1085, 1431 and
500B. Comparison of Frequency Standards. R. Mitsuda, K. Tani and Y. Kusunose.
632B. Time of Occurrence of Dellinger Effect. B. Beckmann, W. Menzel and F. Vilbig.

PHOTOELECTRICITY.

***1426. New Type of Photoelectric Cell. G. Déchêne.** *Comptes Rendus*, 208. *pp.* 95–97, *Jan.* 9. 1939.—The cell described consists of a layer of compressed mercuric oxide, 2–3 mm. thick, with a transparent anode of cellophane which has been soaked in H_2SO_4 and a kathode of Hg. It is used with an applied p.d. of a few volts. The cell shows a dark-current. The photo-sensitivity is very roughly one-tenth of that of the best rectifier cells. The sensitivity is maximum in the green, but it extends through the u.-v. to about 2300 Å. The current-intensity relation under different conditions is briefly described, and it is concluded that the cells would be useful in qualitative, but not in quantitative, applications. **Errata,** *ibid. p.* 472, *Feb.* 6, 1939. D. H. F.

1427. Action of Light on Thin Metallic Sheets. Q. Majorana. *Accad. Lincei, Atti*, 28. *pp.* 132–136, *Sept.*, 1938.—This subject has been dealt with in various preceding papers and further experiments are now described. Thin sheets of gold were intermittently illuminated by light from a Hg or incandescent lamp placed behind a rotating disc with gaps around the periphery. A pulsating electric current was produced in the gold sheet which was compensated by means of a photo-cell arrangement. The value of $\Delta r/r$ (maximum variation of the electric resistance of the sheet) was measured, and also the alteration of phase, ϕ, between the pulsation of the light and that of the electric resistance. When the thickness of the sheet is above that for which a trace of optical transparency appears the action of sources of radiation of different nature is sensibly identical. [See following Abstract.] J. J. S.

1428. Action of Periodic Light on Thin Sheets of Gold. Q. Majorana. *Accad. Lincei, Atti*, 28. *pp.* 137–142, *Sept.*, 1938.—Further experiments are described [see preceding Abstract]. Various results obtained are not capable of explanation by the pure thermal theory, but indicate the existence of a photoelectric phenomenon of a new nature. J. J. S.

1429. Thermal Theory of Metallic Photo-Resistance. Q. Majorana. *Accad. Lincei, Atti*, 28. *pp.* 177–182, *Oct.*, 1938.—Metallic photo-resistance is the name given to the increase of electrical resistance which a thin metallic plate undergoes on exposure to light. In relation to this a theoretical discussion is given based on the classical theory of the propagation of heat. But the pure thermal action of the light is not sufficient to explain all the characteristics of the effect in question. How far the theory applies to the experimental results is to be dealt with in a succeeding paper. [See preceding Abstract.] J. J. S.

See also Abstract 1159 and
609B. Non-Additive Effects of Light on Photo-Cells. G. Liandrat.

PIEZOELECTRICITY.

1430. Multi-Wave Emission from Vibrating Quartz Plates. R. Schiffermüller. *Zeits. f. techn. Physik*, 19. 11. *pp.* 469–475, 1938.—Optical and electrical experiments are described which show that thin quartz plates emit a series of natural frequencies in the neighbourhood of the fundamental frequency of the plate. These extra frequencies appear to be associated with definite parts of the plate. When the quartz is provided with adherent electrodes of powdered metal, the number and range of resonant frequencies is increased. With electrodes of this kind the effect of the vibrations on the electrical resonance circuit disappears, but in the absence of such electrodes the multi-wave emission can be detected in the electrical resonance circuit. G. E. A.

1431. Absolute Frequency of Piezoelectric Quartz Oscillators. S. K. K. Jatkar. *Indian Inst. of Science, J.* 22*A*. 1. *pp.* 1–17, 1939.—The quartz oscillator to be calibrated is made to control a two-stage unsymmetrical multivibrator, through one of the multivibrator's harmonics. By this means the frequency is stepped down in a known ratio, and the output compared with a standard clock. Full details are given of measurements on a variety of crystals. [See Abstract 1318 (1939).] J. P. A.

THERMIONICS.

1432. Fluctuation Theorem (Shot Effect). N. Campbell. *Cambridge Phil. Soc., Proc.* 35. *pp.* 127–129, *Jan.*, 1939.—A discussion of the interpretation of terms used in the fluctuation theorem. [See Abstract 3038 (1938).] N. M. B.

1433. Emission Centres on Upper Surface of Oxide Kathode. W. Heinze and S. Wagener. *Zeits. f. techn. Physik*, 20. 1. *pp.* 16–26, 1939.—Detailed examination of the factors governing the production and action of emission centres on the upper surface of an oxide kathode. Many photographs of surfaces by electron diffraction, by the electron microscope and by X-ray analysis are reproduced. The effects of residual gases and of foreign substances are examined and the influence of the following factors is assessed: (*a*) geometrical sheet thickness, (*b*) effective sheet thickness, (*c*) different proportions in the components of mixed layers, (*d*) orientation of the emitting surface to the crystal system, (*e*) surface roughness, (*f*) magnitude of the surface work function. F. C. C.

THERMOELECTRICITY.

1434. Thermo-E.M.F. in Metal/Semiconductor/Metal Elements. Part II. H. Schweickert. Part III. W. Rohde. Part IV. G. Mönch. *Ann. d. Physik*, 34. 3. *pp.* 250–279, *Feb.*, 1939.—Continuing earlier work [see Abstract 4426 (1936)] the thermoelectric properties of $Cu/Cu_2O/Cu$ elements are investigated. In agreement with earlier results the thermoelectric power is found to increase with decreasing temperature. The thermo-e.m.f. does not increase linearly with the temperature difference; the thermoelectric power is constant only if the temperature difference is greater than 4° C., and increases for lower values. Bends in the conductivity curves are observed at 30° C. and − 70° C. and the behaviour of the thermoelectric power in these regions is investigated. The dependence of the thermoelectric power upon temperature difference at various temperatures and also upon the manner in which the temperature difference is produced is investigated. Finally the experimental and theoretical results for Cu_2O are discussed and correlated. A. G. Q.

See also Abstracts 923, 1271.